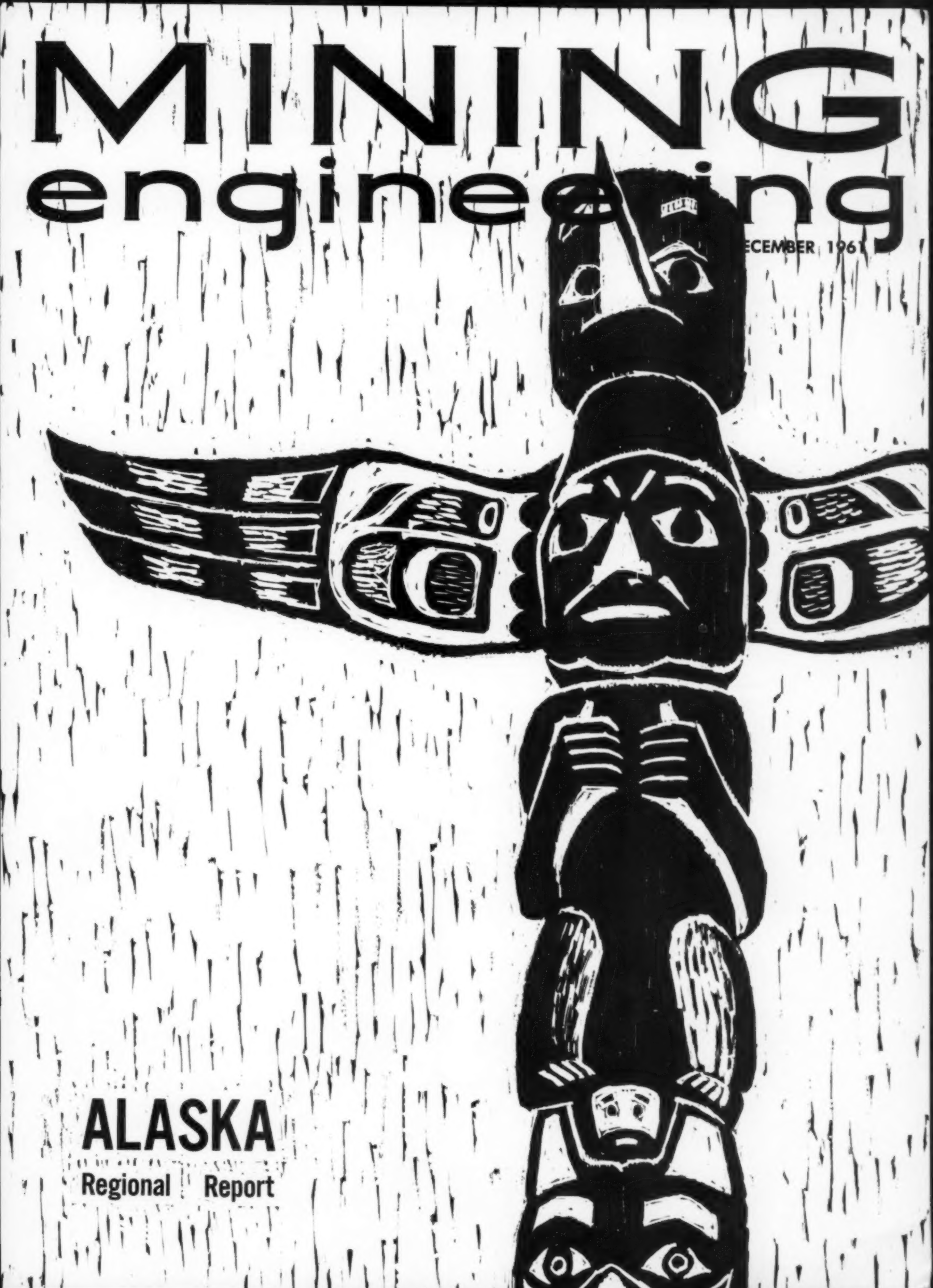
MINING engineering

DECEMBER 1961



ALASKA

Regional Report

COMING EVENTS

Jan. 15-17, 1962, AIME Minnesota Section Annual Meeting-University of Minnesota 23rd Annual Mining Symposium, Hotel Duluth, Duluth.

Feb. 18-22, AIME Annual Meeting, Statler-Hilton & Astor Hotels, New York City.

Mar. 12-13, Steel Founders' Society of America Annual Meeting, Drake Hotel, Chicago.

Mar. 26-29, AAPG-SEPM Annual Meeting, jointly with AAPG-SEPM-SEG Pacific Sections, Civic Auditorium, San Francisco. Fairmont Hotel to be hotel headquarters.

Apr. 5-6, ASME-SAM Management Engineering Conference, Statler-Hilton Hotel, New York City.

Apr. 9-11, 45th National Open Hearth and Blast Furnace, Coke Oven and Raw Materials Conference, sponsored by The Metallurgical Society of AIME. Sheraton-Cadillac Hotel, Detroit.

Apr. 9-13, ASME Metals Engineering Conference, Sheraton Cleveland Hotel, Cleveland.

Apr. 12-14, AIME Pacific Southwest Mineral Industry Conference, Palace Hotel, San Francisco.

Apr. 23-25, 12th Annual Meeting, Rocky Mt. Section, AAPG, Salt Lake City.

Apr. 26-28, AIME-ASM Pacific Northwest Metals and Minerals Conference, Ben Franklin Hotel, Seattle, Wash.

May 3-5, 5th Rock Mechanics Symposium, University of Minnesota, Minneapolis.

May 7-9, American Mining Congress Coal Convention, Pittsburgh.

May 7-11, American Foundrymen's Society 66th Annual Castings Congress & Exposition to be held in conjunction with the 29th International Foundry Congress, Cobo Hall, Detroit.

May 11-13, Seventh Annual Uranium Symposium, sponsored by the Uranium Section of AIME, Moab, Utah.

May 28-June 1, 4th International Coal Preparation Congress, Harrogate, England.

June 4-6, 1962, Nuclear Congress and Atomic Exposition, New York Coliseum, New York City.

June 7-8, AIME Coal Division Field Meeting, Price, Utah.

Sept. 9-13, SME Fall Meeting, Gatlinburgh, Tenn.

Sept. 13-14, Joint Engineering Management Conference, Roosevelt Hotel, New Orleans, La.

Sept. 17-20, SEG, 32nd Annual International Meeting, Calgary, Alta., Canada.

Sept. 24-25, Fall Meeting of The Steel Founders' Society of America, The Homestead, Hot Springs, Va.

Sept. 24-26, ASME-AIEE National Power Conference, Lord Baltimore Hotel, Baltimore, Md.

Sept. 24-27, AMC Mining Show: Metal Mining —Industrial Minerals, San Francisco.

Oct. 4-5, AIME-ASME Joint Solid Fuels Conference, Penn Sheraton Hotel, Pittsburgh.

Oct. 20-26, Sixth World Power Conference, Melbourne, Australia

Nov. 2, Pittsburgh Sections of AIME and NOHC, Off-the-Record-Meeting, Penn-Sheraton Hotel, Pittsburgh.

Nov. 12-14, Steel Founders' Society of America Technical and Operating Conference, Hotel Carter, Cleveland.

SOCIETY OF MINING ENGINEERS AIME

MINING engineering

VOL. 13 NO. 12 ABC **DECEMBER 1961**

COVER *This issue's subject: Alaska. What could convey this message better than the Totem, depicted by artist Herb McClure?*

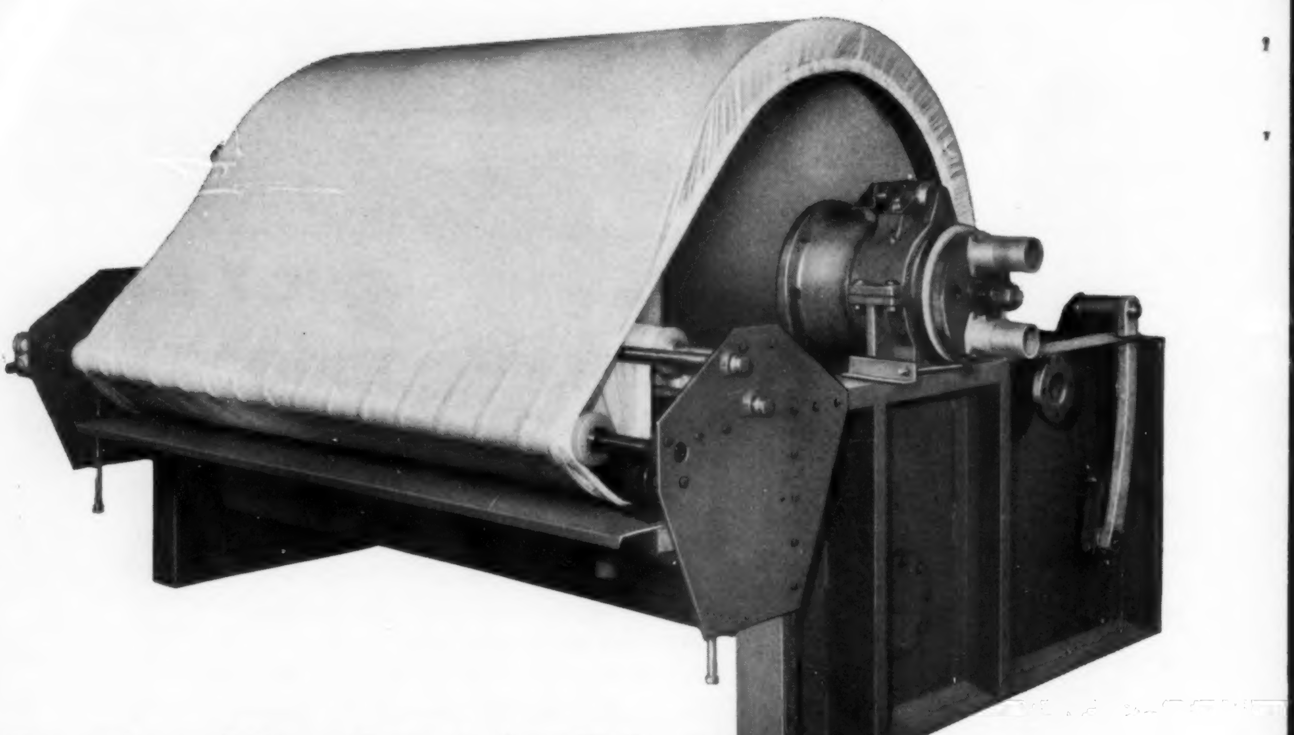
ALASKA: REGIONAL REPORT

PLUS

DEPARTMENTS

MINING ENGINEERING staff, Society of Mining Engineers, and AIME Officers are listed with "The Drift Of Things". Number of copies printed of this issue: 15,700.

Address insertion orders and copy to MINING ENGINEERING, 345 E. 47th St., New York 17, N. Y. Send plates to: MINING ENGINEERING, c/o Lew A. Cummings Co. Inc., 215 Canal St., Manchester, N. H. Published monthly by the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., 345 E. 47th St., New York 17, N. Y. Telephone: PLaza 2-6800; TWX NY 1-1304. Subscription $8 per year for non-AIME members in the U. S., & North, South, & Central America; $10 all other countries; $6 for AIME members, or $4 additional for members only in combination with a subscription to "Journal of Metals" or "Journal of Petroleum Technology". Single copies, $.75; single copies foreign, $1.00; special issues, $1.50. AIME is not responsible for any statement made or opinion expressed in its publications. Registered cable address, AIME, New York. Indexed in Engineering Index, Industrial Arts Index, and by National Research Bureau. Second class postage paid at New York, N. Y., and at Manchester, N. H.



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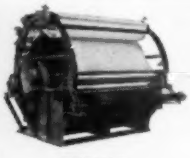

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PERSONNEL

THESE items are listings of the Engineering Societies Personnel Service Inc. This service, which cooperates with the national societies of Civil, Chemical, Electrical, Mechanical, Mining, Metallurgical, and Petroleum Engineers, is available to all engineers, members or nonmembers, and is operated on a nonprofit basis. If you are interested in any of these listings, and are not registered, you may apply by letter or resume and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular placement fee. Upon receipt of your application a copy of our placement fee agreement, which you agree to sign and return immediately, will be mailed to you by our office. In sending applications be sure to list the key and job number. When making application for a position include 8¢ in stamps for forwarding application. A weekly bulletin of engineering positions open is available at a subscription rate of $4.50 per quarter or $14 per annum, payable in advance. Local offices of the Personnel Service are at 8 W. 40 St., **New York 18;** 57 Post St., **San Francisco;** 29 E. Madison St., **Chicago 1.**

In addition to the listings below, ESPS maintains a more complete file of general engineering positions and men available. Contact nearest ESPS office, listed above.

MEN AVAILABLE

Mine Operation and Production Engineer, mining engineering, age 28, married, one child. Supervision of up to 200-tpd operation (cross cuttings, drifting, raising, shaft sinking), open-cut and underground stope preparation and stoping (open-cut, shrinkage, cut and fill etc.). Assisted chief engineer in all phases of mine engineering for one year. M-631.

Canadian Mining Geologist, geological engineering, age 29, married. Experienced assistant mine geologist (3000-tpd trackless mine); resident geologist, Mexico. Presently mine geologist (500-tpd gold-quartz mine). Fluent Spanish. Any location. M-632.

Research Mineralogist, Ph.D. degree in mineralogy. Five years laboratory research investigating properties of clays and oil shales, beneficiation of beryllium ores and lateritic iron ores, development of new processes and application in ceramics. Location open. M-633.

Exploration Mining Geologist, B.S. degree in geology, one year law, age 34. Six years experience in Mexico with major and small companies. Exploration, diamond drilling, mine development and production. Mine examination and reports. Some flotation mill experience. Managerial and administrative duties. Fluent Spanish. Any location. M-2212-Chicago.

Mining Engineer, B.S. degree, age 31. Six years experience underground mining including surveying, mineral beneficiation, new plant development. Interested in production or engineering position. Salary and location open. M-2307-Chicago.

Research and Development, Sales Engineer, Consultant, B.S. degree in geological engineering, age 44. Twenty years exploration, development, evaluation, diversified building materials, nonmetallic and rare earth minerals, ground water and industrial minerals including ten years design, construction, operation, management, sales and six years diversified research and development. Location open, M-2308-Chicago.

Maintain, Transport-Oil, Mine, mechanical background, age 45. Fourteen years in South America as general transport superintendent, responsible for budgeting, programing, planning and administration for operating, maintaining, repairing and overhauling a transport fleet of over 500 units consisting of cars, trucks, buses, dump trucks, tractors, draglines and road graders. $12,000. Any location. Home: Arizona. Se-1492.

Field-Mining, M.E. degree (Canada), age 36. Nine years experience in heavy construction, mine tunnels, shafts and subways in contract management. Liaison work, layout, field inspection, design. Seeks permanent connection with progressive contractor or developing mining organization. $10,000. Prefer Canada, West or foreign. Home: Ontario. Se-1523.

Mining, mining and metallurgical engineering degrees, age 53. Twenty-five years mine management foreign and domestic, mining engineer for large underground metal mine, work in uranium, copper, gold, lead, zinc, silver. Any location. Home: Arizona.

Geologist, Geophysicist-Mining, degree in geology, 52. Twenty-four years as mining geologist-geophysicist throughout Canada, southwestern U.S., Mexico and Italy. Accustomed to organizing and directing large scale exploration projects. Free to travel and work anywhere. Salary open. Prefer West. Home. California. Se-1356.

Geology-Mineral, degree in geology (Canada), age 34. All phases mining and exploration geology. Specialize in property examination and mine evaluation. Sound education in mining and geology. Experience in asbestos, gold, uranium and base metals. $9000. Prefer West or Canada. Home: California.

Mining-Metallic, Nonmetallic, mining engineer, age 27. Three years experience in mine supervision, planning, reserves, geological mapping, surveying, claim location, drilling, sampling, core logging in coal and uranium. $700. Prefer West. Home: New Mexico. Se-1776.

Mining, degree in mining engineering, age 32. Seven years experience in underground and open pit mines, including surveying, mapping, ore reserve estimates, supervision of open pit operation and some design and planning. $650. Any location. Home: New Mexico. Se-1542.

Mining-Metal, degree in mining engineering, age 25. Recent graduate with one month experience supervising blasting; five months experience in drilling, blasting, roof bolting and mucking. $500. Prefer foreign. Home: Colorado. Se-1527.

Draft-Civil, Mechanical, Map, mining geologist, 62. Layout, assist in design, detail, draft for consultant, contractor, companies, one geological mapping, cement plant, airports, city and country maps, heavy construction. $500. Prefer San Francisco Bay area. Home: California. Se-1594.

Geologist-Mining, degree in geology, age 26. Three years experience in underground mapping and log core; party chief, diamond drilling, gold. $475. Prefer California, foreign. Home: California.

POSITIONS OPEN

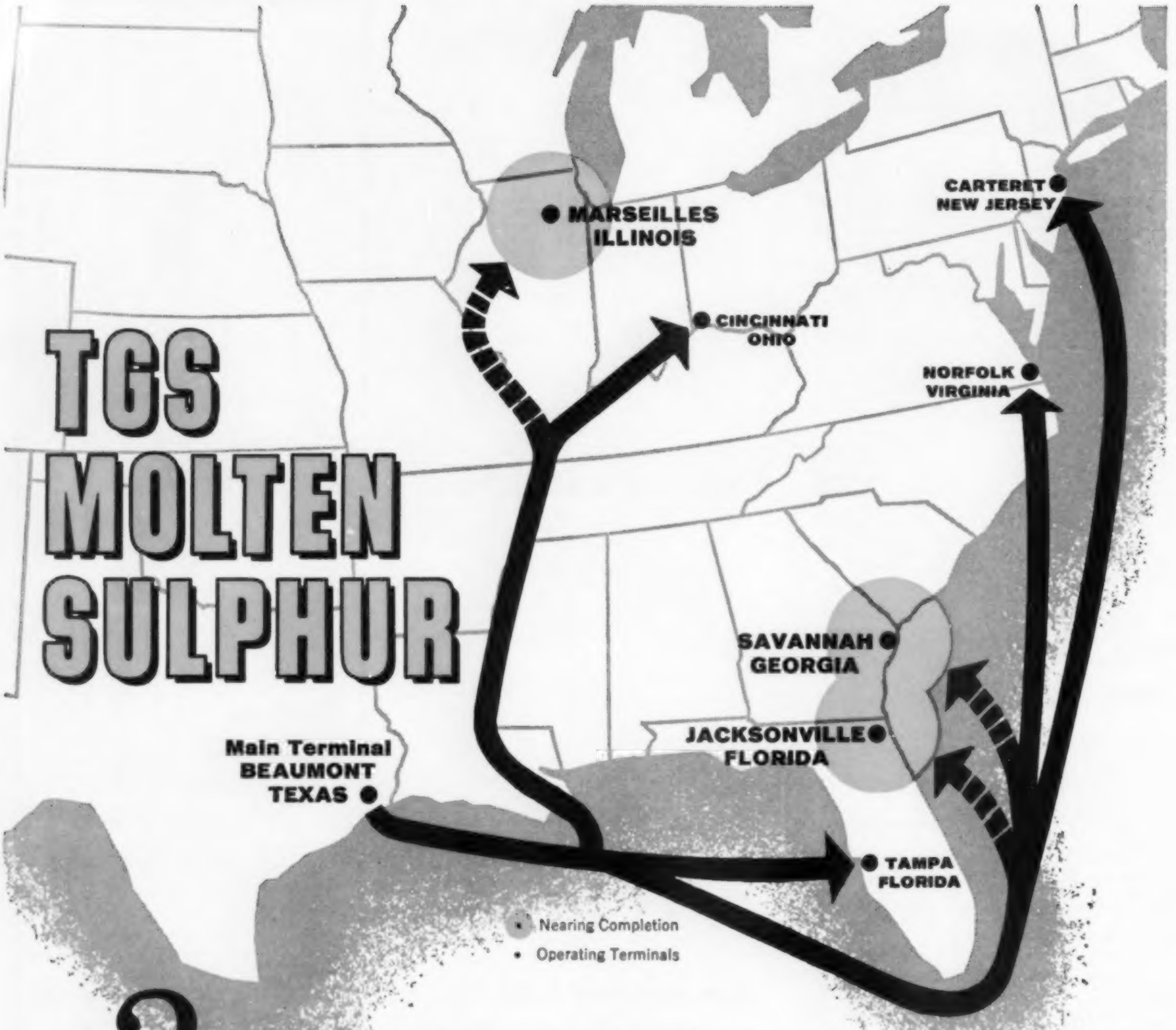
Mine Geologist, young, with several years experience in underground mine and general exploration program. Single status preferred. Salary open. Foreign. F909.

Mining Engineer, experienced, with some background in mining or quarrying marble or hard limestone materials, involving open pit and underground mining. Should be capable of long range development planning and direct responsibility and supervising of operations. About $7500 plus profit sharing and fringe benefits. South. W893.

* * *

Mineral Economist (General), GS-11, 12 or 13, B.S. degree with 24 semester hours of economics or four years of progressive general experience in economics that reflects a professional knowledge comparable to that acquired in a four year course or a combination of experience and education; plus three years of advanced experience in mineral economics or the economics of related fields or commodities. Graduate study may be substituted for part of the advanced experience required. Will be responsible for planning, conducting and reporting specialized economic research, investigation and analysis concerning the Bureau of Land Management's minerals function. $8,955 or $10,635 (depending on background). Washington, D. C. To apply: Send Standard Form 57 to Personnel Officer, Bureau of Land Management, Room 5558, Interior Bldg., Washington 25, D. C. *no later than Dec. 15, 1961.* For further information call RE 7-1820, Ext. 4603.

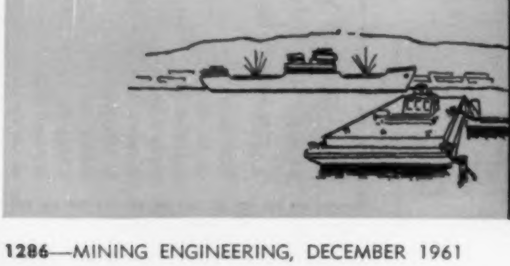
For further information, circle the following numbers on the reader service card: 5, Bull. 248A; 6, Bull. 265A; 7, Bull. 243A; 8, Bull. 207B; 9, Bull. 261A.



3 More Regional Supply Terminals ... Nearing Completion

Three additional major sulphur-consuming areas will soon be served with short-haul deliveries of TGS Molten Sulphur. As a matter of fact, at Jacksonville the service is even broader for we will also be stockpiling solid sulphur. Facilities are being set up to 'vat' part of the molten sulphur as it comes in by tanker from Beaumont. We're already providing this dual service at Norfolk.

These three terminals will be ready early in 1962. That will make a total of seven supplying TGS Sulphur to major sulphur-consuming areas with short-haul deliveries.



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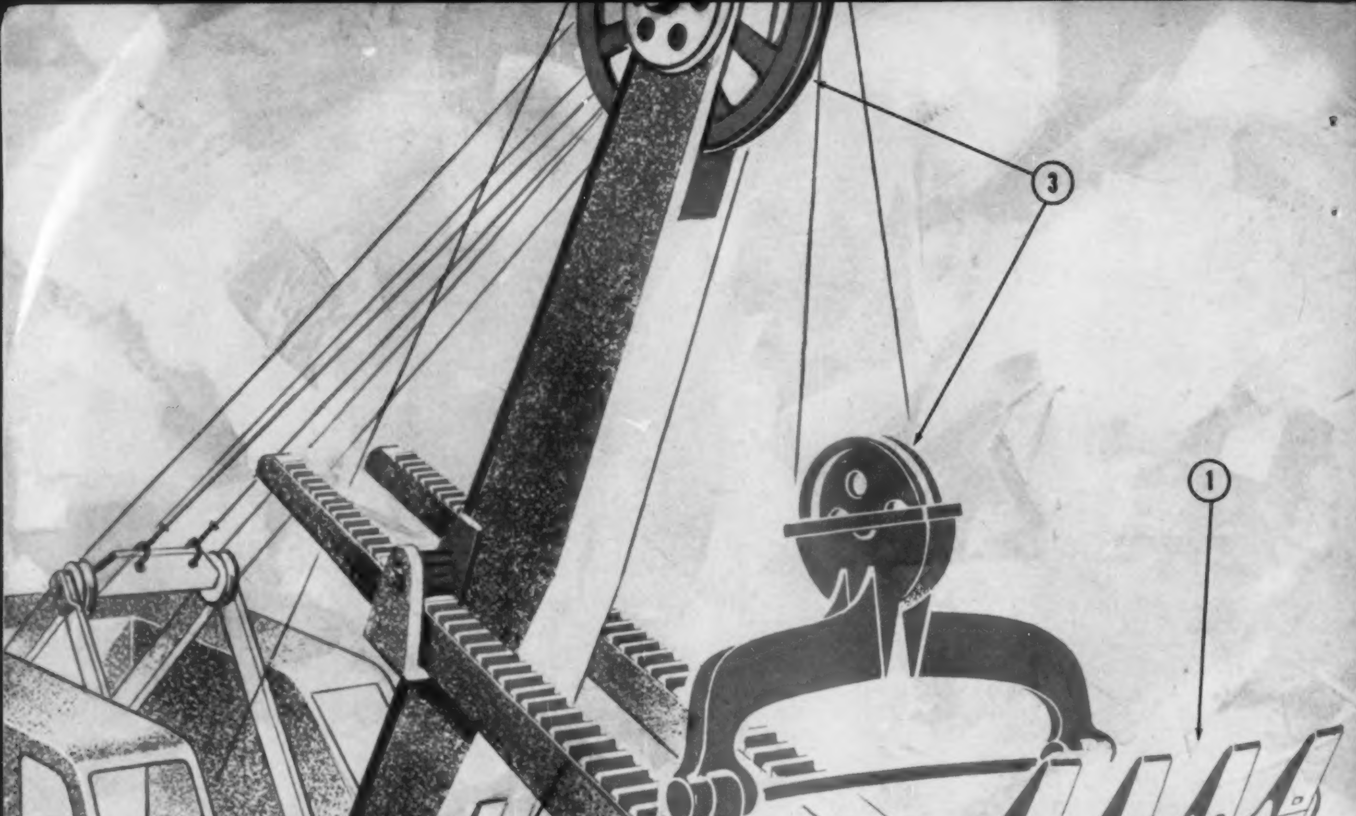


(1) Cut tooth costs up to 75% with Amsco Simplex 2-part reversible dipper teeth. Amsco Simplex teeth give you longer digging life while maintaining sharpness. Positive point-to-adapter pin locks stay tight under extreme conditions of impact, side blows, vibration or other shock. Simplex points stay on and are reversed in minutes per dipper. Replace present teeth with Simplex and measure the difference.

(2) Amsco dippers are made of manganese steel—"the toughest steel known"—containing 12-14% manganese. This tough steel provides as much as a 10 to 1 advantage over carbon steels under the abuse of impact and abrasion. Amsco manganese steel work hardens under impact, self-polishes under abrasion and is easy to weld when buildup or repair is needed. All types of dippers are made by Amsco—two-piece welded dippers, renewable-lip designs, Mesabi types, special dredge types and other styles to order.

(3) Worn sheaves shorten line life. Wire rope lasts longer when running in sheaves that stay smooth and even throughout their life. Ordinary flame-hardened steel or chilled cast iron sheaves score, wear and splinter. Splinters cut into wire rope. Amsco manganese steel sheaves work harden under repeated impact and acquire a polish that eliminates splinters. And when a high loading bangs the two sheaves together, Amsco sheaves take the beating without breaking.

(4) Tough, reliable Amsco crawler shoes give longer life for any shovel or backhoe. Amsco crawler shoes are available to fit every make of shovel or dragline and in special designs to order. Other Amsco shovel parts include racks, bevel gears, shipper shaft pinions, idlers, sprockets, dipper lips, fronts and doors. See your power shovel manufacturer for parts that give maximum service life and satisfaction.

BOOKS

Order directly from the publisher all books listed below except those marked • • • The books so marked (• • •) can be purchased through AIME, usually at a discount. Address Irene K. Sharp, AIME Book Dept., 345 E. 47 St., New York 17, N. Y.

Molybdenum by Hans P. Rechenberg, *Ferdinand Enke Verlag*, Stuttgart, Germany, 1960, 126 pp., approx. $6.80 (DM 27.00)—This 12th volume of a series on the metals gives for each producing country the location and extent of molybdenum ores, brief descriptions of the deposits and, in most cases, production figures. The first 47 pages are devoted to summarized general information on the properties and characteristics of molybdenum, its minerals, exploitation, uses, markets, resources and future outlook. The information sources consulted are indicated. • • •

Coke Production Costs in the U.S.A., 1960 (Cost Comparison of Various Coke Production Methods), *Economics Research Dept., Shallway Corp.*, 1450 University Avenue, Palo Alto, Calif., 1961, $7.50—This report uncovers confidential operating cost figures never before revealed. It averages and summarizes actual cost data for the year 1960 from figures furnished by coal, coke and steel company officials for the following types of oven: vertical slot-type (byproduct), horizontal slot-type (semi-byproduct), horizontal slot-type (nonrecovery) and beehive (nonrecovery). The report includes summary data on the following costs: capital cost, capacity and operating cycle, coke yield, space requirement, operating labor requirement, operating labor cost and byproduct values. • • •

The Training, Placement and Utilization of Engineers and Technicians in the Soviet Union, report of an EJC delegation to the USSR in July 1960, *Engineers Joint Council*, 345 E. 47th Street, New York 18, N.Y., 1961, 112 pp., $1.00—Recent achievements and future goals of the Soviet Union in the field of engineering and engineering education and manpower utilization are presented in this report. It is divided into six sections covering engineering and technicum education in the USSR; planning of manpower requirements and placement of graduates; continuing education of engineers and technicians

employed in Soviet industry; motivation in education; industrial research; and utilization of engineers and technicians. The comprehensive report includes footnotes, statistical data and photographs.

The Flotation Index—1960, 31st Annual Edition, *The Dow Chemical Co.*, Midland, Mich., 1961, gratis—This is a bibliography of 517 articles which have appeared in leading mining publications. Material covering flotation research, general mineral dressing and milling operations include journal references listed alphabetically by journal title. Patents are listed alphabetically by country; books, documents and symposia are listed alphabetically by book or document title; and individual citations are indexed by subject.

Profitable Use of Excavation Equipment by Elmer R. Drevdahl, Jr., *Desert Labs. Inc.*, P.O. Box 4666, Tucson, Ariz., University Station, $10.00 plastic binding, $13.50 cloth—This book is designed to be used as a standard for estimating capabilities and costs of excavation equipment as used in construction and mining industries. It provides a complete analysis giving a reference point for equipment systems simulation, analysis and profit. Covered are fundamentals of equipment analysis with reference information, information on equipment output and costs and complete tables. Written in everyday language, the book makes dollars and cents out of any cost system by telling how to keep and use a record that will open into an amazing picture. Profits are not guesses—they are planned. The profitable application of principles is only the beginning of a planned profit picture. Simple cost accounting based on prior experience, the use of data, available but often not assembled, are the means to lower costs. Depreciation methods are also fully treated.

1961 Refractories Product Directory, *The Refractories Institute*, First National Bank Bldg., Pittsburgh 22, Pa., 1961, 224 pp., $4.50—This latest directory of the Refractories Industry (the last one was published in 1958) lists 3548 different brands of refractories for the lining of the industrial furnaces of the nation, an increase of 24% over the last one. It is the only single source of information on "who makes what and where" in the industry, giving a company-by-company breakdown of products. The 170 companies listed represent almost 100% coverage of the industry. Special sections of the directory are devoted to manufacturer's names and addresses, plant locations by state and city, product divisions and a complete list of brand or trade names.

Conference on Minerals, *Central Treaty Organization (CENTO)*, Offices of the U.S. Economic Coordinator for CENTO Affairs, American Embassy, Ankara, Turkey, 1961, 69 pp., gratis—Containing the four papers presented at the Conference on Minerals, Ankara, Turkey, 1959, this book covers the topics of "The Possible Role of Minerals in the Economy of CENTO," plus three papers detailing the mineral position of Iran, Pakistan and Turkey by leading government mineral specialists of those countries.

CANADA

Ontario

Publications Office
Dept. of Mines
Toronto, Canada

Geologic Map of Township 137, District of Algoma, 2003, 1961, gratis.
Geologic Map of Township 138, District of **Algoma,** 2004, 1961, gratis.
Preliminary Map of the Port Coldwell Area, District of Thunder Bay, P.114, 1961, $1.00.
Preliminary Map, Lots One to Six, Concessions I to VI of Coleman Township, District of Timiskaming, P.97A, 1961, $1.00.
Preliminary Map of Parts of Townships 167 and 168, District of Algoma, P.115, 1961, $1.00.
Preliminary Geological and Geophysical Map of Part of Dome Township, Red Lake Mining Division, P.93, 1961, $1.00.
Preliminary Geological and Geophysical Map of Part of Balmer Township, Red Lake Mining Division, P.94, 1961, $1.00.
Preliminary Geological Map of the Georgia Lake Area, District of Thunder Bay, 1961, $1.00.
Preliminary Geological Map of Searfe Township, District of Algoma, uncolored print, 1960, 50¢.
Preliminary Geological Map of Cobden Township, District of Algoma, uncolored print, 1960, 50¢.
Preliminary Geological Map of Mack Township, District of Algoma, uncolored print, 1960, 50¢.
Preliminary Geological Map of Striker Township, District of Algoma, uncolored print, 1960, 50¢.
Preliminary Geological Map of McGiverin Township, District of Algoma, uncolored print, 1960, 50¢.
Preliminary Geological Map of Long Township, District of Algoma, uncolored print, 1960, 50¢.
Mining Court and Mining Commissioners' Cases, 1918-1960, a digest of all the more important decisions handed down under the Ontario Mining Act since 1918, 1961, $10.00.

Quebec

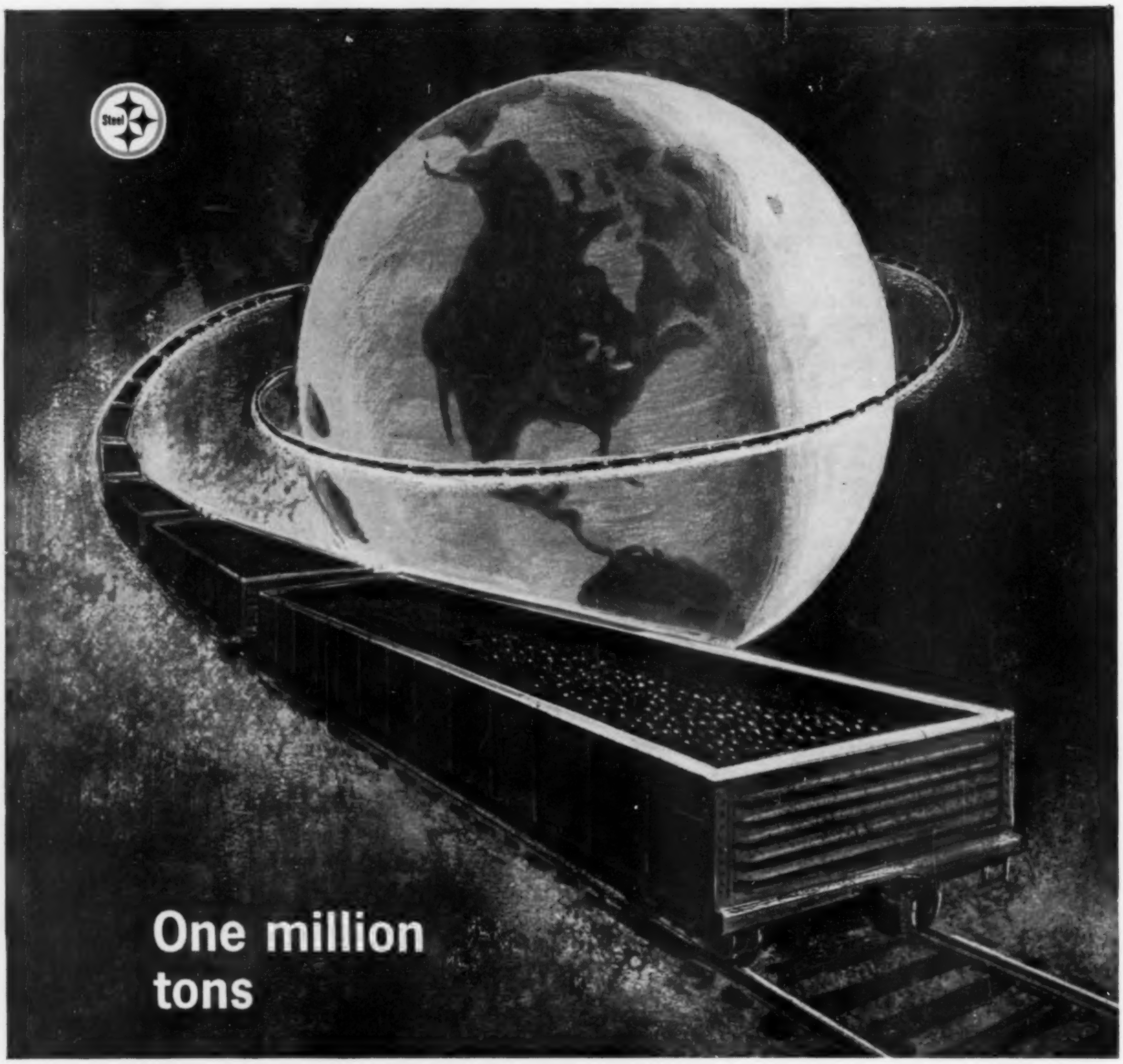
Dept. of Mines
Hotel du Government
Quebec, Canada

Iron Ore Deposits of the Province of Quebec, Preliminary Report, P.R. No. 409, 1960, gratis.

ABSTRACTS

In This Issue: *The following abstracts of papers in this issue are reproduced for the convenience of members who wish to maintain a reference card file and for the use of librarians and abstracting services. At the end of each abstract is given the proper permanent reference to the paper for bibliography purposes.*

Alaska: Regional Report—Composed of articles pertaining to the general geology of the state, prospecting, mining laws and the economics of mining. Report includes analyses of operations at two coal properties and the Red Devil mercury mine. A 20-year projection of Alaskan mineral production concludes this report on the present and potential mineral industry of the state. **Ref.** (MINING ENGINEERING, **December 1961) p. 1316.**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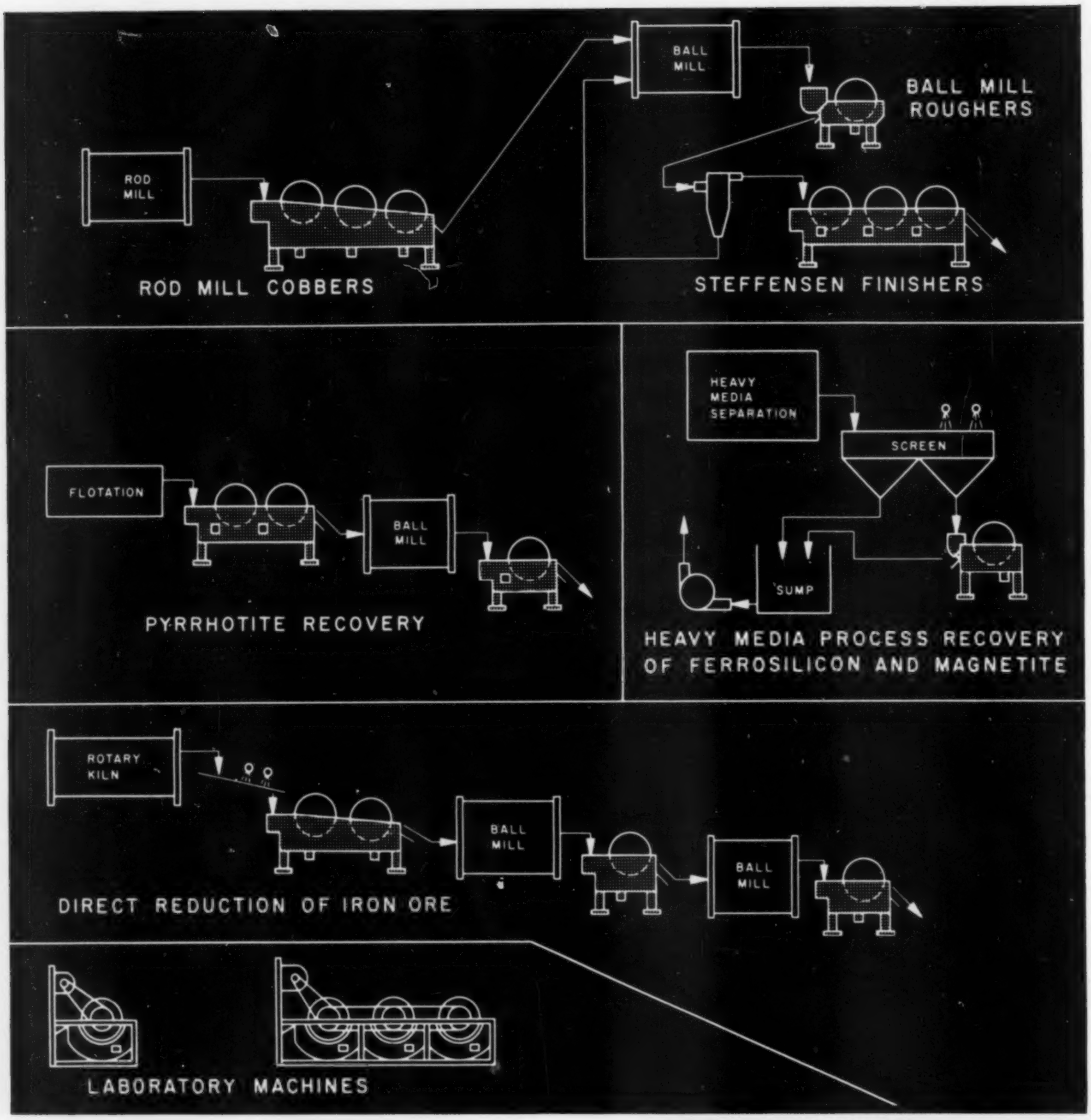

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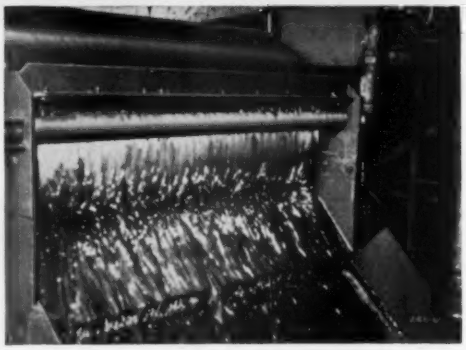

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12 MINING ENGINEERING Not good after March 15, 1962

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"Only satisfactory equipment to do job" says George R. Stunden, Contract Manager, Atlas-Robertson.

North Bay, Ontario, Canada—Canada's SAGE computer center is entirely underground and is considered to give the best possible protection of any installation of this type in the world. The main chambers are an excavated 200,000 cu. yd. hole with an additional 100,000 cu. yds. of tunnels, etc. also in solid rock, one of this continent's largest underground caverns and the first tunneled, rather than cut and cover, SAGE installation. A free-standing, steel frame building will be erected within this man-made cavern.

Access to the main chambers is by two adits, both driven at - 10% gradient. The south main adit was a 16 by 17 foot heading, over half a mile long. Two Eimco 105 Tractor-Excavators were used here to highball the heading, so that the main chamber could be started as quickly as possible, working around the clock and loading directly into trucks. Says John H. Douglas, Resident Engineer: "At the start of the job, there was some concern about the Eimco 105 Excavators' ability to load on these grades and further, whether or not they could properly load trucks. However, no trouble was encountered and the Eimco 105's worked extremely well and the trucks were loaded full".

The north adit, well over a mile long, was a 12 by 13 foot heading again driven at a -10% gradient. Here, two Eimco 630 air-powered Excavators were used to load into a monorail mounted conveyor loader which, in turn discharged into 6 cu. yd. cars. A train consisted of five cars and hoisting was done with a six foot diameter mine hoist. By the time this adit had been driven 4,200 feet, the economical limit of the hoist had been reached and so the heading was completed up-grade by the Eimco 105 Excavators. A third Eimco 105 Excavator was introduced at this point, because additional work was being done in the chambers at the same time.

Patrick Harrison & Company did the 6 by 7 foot tunnel work and raising on a sub-contract, using an Eimco 21 RockerShovel Loader.

Consulting Engineers were A. D. Margison & Associates of Toronto, with John H. Douglas as Resident Engineer. General Contractors were Atlas-Robertson (Joint Venture) with headquarters at Montreal. George R. Stunden was contract manager, Glen West, Superintendent; John E. Cain, master mechanic; H. J. (Dick) Dawson, project engineer.

All the tunnel work and some of the chamber excavation on the SAGE project was done with three Eimco 105 Diesel Powered Excavator-Loaders; Two Eimco 630 Air-Powered Excavator-Loaders and one Eimco 21 RockerShovel Loader.

Atlas-Robertson were serviced by Mine Equipment Company, Dealer in Canada for The Eimco Corporation, direct from their North Bay warehouse, only a few miles from the job site.

For further details and specifications on dependable Eimco equipment, contact the dealer or branch nearest you, or write The Eimco Corporation, P. O. Box 300, Salt Lake City 10, Utah, U.S.A. for "Tunneling Bulletins."

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The proof is in the picture. The worn liner on the far right shows you how Ni-Hard liners keep their contour right down to the last fraction of an inch. That's because Ni-Hard liners not only have outstanding resistance to abrasive wear but also have a uniform wear rate so that you get higher efficiency and longer working life out of the design of your Ni-Hard liners.

Try a set of Ni-Hard liners in your mills. Just contact the Ni-Hard producing foundry in your area. They'll be glad to discuss the design characteristics best-suited for the liners in your mills, glad to give you further information on Ni-Hard liners and how they can help you cut mill-operating costs.

For further information on Ni-Hard iron feed spouts, pipe elbows, and many other parts where abrasion-resistance is required, just drop a note to Inco. We'll send you your free copy of the useful 58-page booklet, "Engineering Properties and Applications of Ni-Hard" and a list of Ni-Hard producing foundries.

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JAPAN'S BIG IRON SOURCE—BOTTOM OF TOKYO BAY

At a recent conference at the University of Southern California, Dr. Hiroshi Niino, marine geologist at Tokyo University, described a Japanese marine operation which in the past four years has dredged seven million tons of iron ore from the ocean floor of Tokyo Bay.

The marine mining has been accomplished in waters 90 ft deep. Dr. Niino said this ore is of very high grade and the new source is one of the major deposits of iron ore of Japan. The marine geologist asserted that marine iron mining is a very promising field.

It was also reported at this meeting that the Soviet Union is quite seriously engaged in marine mining. They are said to have a fleet of 6000-ton research vessels on scientific voyages in the Arctic, Atlantic and Pacific oceans.

GUINEA GOVERNMENT SEIZES ALUMINUM PLANT

It has recently been reported that the government of Guinea has expropriated the assets of Aluminum, Ltd. in that country. This action was taken upon the company's inability to finance a proposed $175 million bauxite and aluminum project in the nation's Boke region. The expropriation loss has been estimated at about $20 million.

FLOTATION PROCESS USED FOR NEVADA ORE

The U.S. Bureau of Mines has developed a flotation process for the bertrandite-phenakite ore of the Mt. Washington mining district which is being developed by Anaconda Co. under agreement with Mt. Wheeler Mining Co. The Bureau reports the flotation was employed on a batch process with high recoveries of ore ranging from 0.49% to 0.73% BeO. One sample registered 5% BeO.

NEW MINING METHODS HELP S.AFRICA INDUSTRY

Hugh M. McGregor, director of Production-Engineering Ltd., London, international management consultants, presented a bright picture of South Africa's investment climate as he outlined opportunities in mining, earthmoving and consumer goods fields. The address was given at a recent luncheon at the Wall Street Club in New York City.

The articulate spokesman described a new concept of stability in mining profits which has been developed in African gold, copper, tin and other operations through application of detailed methods studies and cost control procedures, combined with a systematic approach to ore reserve control. These new techniques have made possible accurate prediction of annual output and profits within a 4% variant, reported Mr. McGregor. The control techniques employed at properties of the

NEWS FROM MINE AND MILL

Ashanti Goldfields Corp. Ltd., Ghana reduced the cost per ton approximately 20% (despite almost doubled rates of pay), raised profits 250% and doubled shareholders equity in a five-year period.

BIG PLANS MADE FOR ALABAMA IRON ORE

Commonwealth Mining Co., a new firm, has made agreements with Glenwood Mining Co. and Southern Development Co. which gives Commonwealth full control over iron ore deposits covering 35,000 acres in southern Alabama.

The strip mines in this area are expected to produce some two million tons of ore per year to be shipped to Japan and Germany. A shipment to Japan is planned for February 1962. The company is said to be planning to concentrate the ores to 58% Fe.

COAL INDUSTRY REACTS TO PROJECT GNOME BLAST

The long-awaited atomic blast to test peaceful use of nuclear energy is scheduled for early December in an underground salt formation near Carlsbad, N. M. (see MINING ENGINEERING, June 1961, page 548). One aim of the Project Gnome experiment is to learn whether the heat trapped from the underground blast can be used to make steam for the generation of electricity. The Atomic Energy Commission estimates that if all the heat from the $5.5 million blast could be recovered, it would produce some 6.25 million kw-hr of electricity.

In the National Coal Association's *Coal News* the point was made that, "Since the electric utility industry last year could produce one kilowatt hour from .88 pounds of coal, the AEC's $5,500,000 experiment would produce—at maximum efficiency—the electricity that could be generated by 2,751 tons of coal at a cost of $17,221, since coal 'as consumed' cost the utilities an average of $6.26 a ton last year." "So put that in your salt mine and smoke it," they seem to suggest.

NEW G.E. LABORATORY STUDIES DIAMONDS

General Electric Co. has opened a new laboratory facility to investigate new and improved diamond applications, to evaluate new man-made diamond types and to analyze comparative performance testing operations. The laboratory is equipped with grinding machines with special modifications to permit accurate control of the variables which affect diamond performance.

Research is currently in progress on evaluation of synthetic diamond grinding hardened steels, determination of the feasibility of using diamond in plate glass grinding, and evaluation of the performance of manufactured diamond in blades for masonry cutting applications.

UTAH CONST. & MINING TO OPEN NEV. IRON MINE

Utah Construction & Mining Co. has recently completed development work on an iron ore deposit near Dayton, Nev., and is making plans for a beneficiation plant. The deposit has an estimated reserve of 12 million tons of ore averaging about 50% iron and 3% sulfur. Under a proposed sales contract the company plans to ship about 600,000 tons annually from the open pit operation.

IDAHO PHOSPHATE RESERVES TO BE DEVELOPED

International Minerals & Chemical Corp. and Husky Oil Co. have signed an agreement to develop the latter's phosphate reserves near Soda Springs, Idaho, estimated at 50 million tons.

The agreement provides five years for development of a final plan for undertaking the joint venture, and in the event that Husky should withdraw from the project, International Minerals & Chemical may purchase the deposits.

PITTSBURG & MIDWAY BUYS U.S.'S HIGHEST STRIP MINE

The Pittsburg & Midway Coal Mining Co., subsidiary of Spencer Chemical Co., has purchased the Edna mine of Edna Coal Co. for an undisclosed figure. The Edna mine, at 8000 ft elevation, is the nation's highest strip mine. The mine is located in Routt County, near Steamboat Springs, Colo. This acquisition is expected to increase the company's coal mining capacity in Colorado to a total of about 600,000 tons per year, according to a Pittsburg & Midway spokesman.

BESTWALL GYPSUM PLANS PLANT OPENING

A $7½ million gypsum plant now under construction for Bestwall Gypsum Co. at Wilmington, Del., is scheduled to begin operations in January 1962. The plant will facilitate the manufacture of enough gypsum wallboard, lath and sheathing to complete 30,000 homes annually and all types of gypsum wall plasters as well as graded commercial rock and agricultural gypsum.

The gypsum rock imported from the company's deposits in Nova Scotia and the Dominican Republic is handled at the new Wilmington Marine Terminal dock by a 600-tph ore unloader and a gantry crane capable of lifting 100 tons at a 35-ft radius.

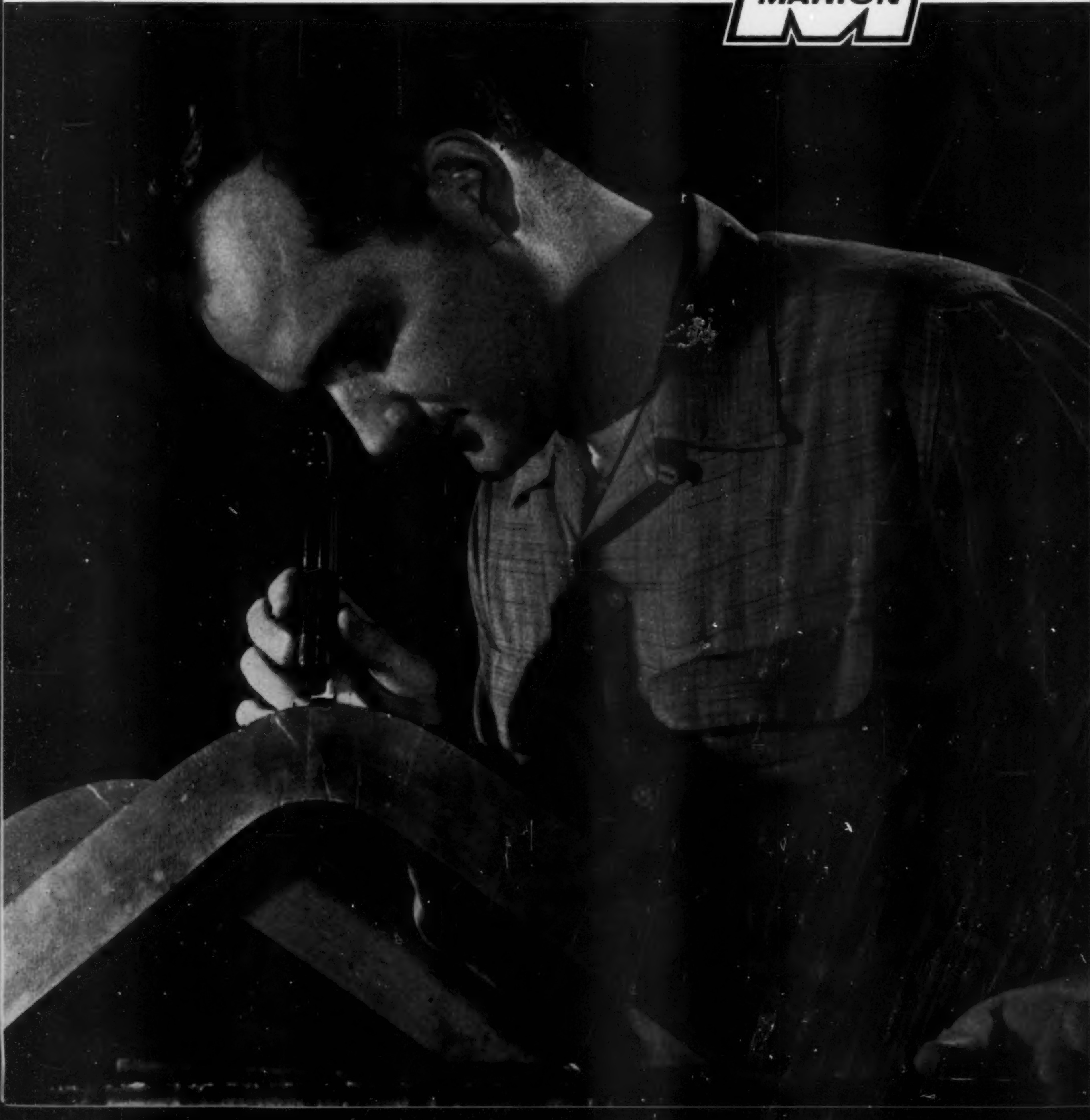
CALLAHAN MINING BUYS NON-METALLIC PROPERTIES

Callahan Mining Corp. will take over the operation of a group of 16 non-metallic mining properties and affiliated processing plants of Huntley Industrial Minerals, Inc.

MISSION PROJECT OFFICIALLY OPENED

On November 16, American Smelting & Refining Co. officially opened its 15,000-tpd copper mine at Mission, Ariz. The new mine actually started production in late July, and its ore has begun to reach the market at 31¢ per lb.

When it reaches final size, the Mission pit will be about one mile long, a half mile wide and 700 ft deep. The concentrator has an annual production capacity of 165,000 tons of concentrates containing approximately 30% copper.



PRODUCTS

FOR MINE AND MILL

Electromagnetic Survey Unit

An electromagnetic survey unit (SE-300) engineered and manufactured by *E. J. Sharpe Instruments of Canada, Ltd.* has already been tested by several geophysicists in prospecting for sulfide deposits. The unit consists of two identical transceiver units which reportedly permit ground to be surveyed at twice the normal operational rate. The transceivers also provide built-in inter-

communication between operators. This dual frequency feature gives discriminatory information regarding conductivity of subsurface conductors and aids in resolving overburden from bedrock effects. A receiver circuitry extends the useful separation of the receivers to at least 1200 ft. **Circle No. 76.**

Vacuum Drum Filter

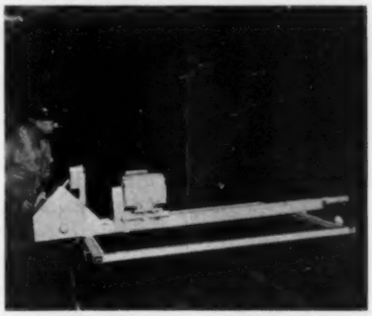
A new belt filter design has been introduced in a full range of sizes and materials by *Dorr-Oliver Inc.* The unit (D-O Webtrol Filter) applies web tracking control and web spreading equipment to a new version of the basic Oliver vacuum drum filter design. A bowed roll spreads and smooths the fabric, holding the medium flat against the filter drum under uniform tension. An edge-position device operates through a modern feedback circuit to adjust continuously a tracking roll located so that it can position the belt directly on the filter drum. The filter is designed for slurries which tend to blind the cloth and to operations where a sufficiently high filtrate clarity cannot be obtained with the usual types of vacuum drum filters. The unit is applicable in such operations as clay dewatering, nickel-cobalt hydroxide washing and potash slimes removal. **Circle No. 77.**

Venturi Scrubber

Buell Engineering Co., Inc. has announced a venturi scrubber for separating entrained solids from high-temperature gases in such industries as iron and steel, non-ferrous metals, mineral products and chemicals. The scrubber subjects the exhaust gases to a double scrubbing action as they pass through a bank of venturis. At each venturi, a nozzle sprays a cone of water into the belled venturi entry. It receives a second scrubbing as it passes through an inverted cone formed as the water rebounds from the belled mouth into the throat of the venturi. This deflection of the water decreases its velocity and breaks it into smaller droplets. While this takes place, the velocities of the gas and entrained solids are increased, due to the narrowing throat of the venturi. The scrubber reportedly cleans gases of dust particles as small as 0.05 microns at efficiencies exceeding 99%. **Circle No. 78.**

One-Man Coal Cutter

A one-man coal cutting machine has been introduced by the *Mighty Miner Co.* Powered by an electric motor driving a 2¾-in. auger bit, this machine drills a series of 15 holes in



a straight line to undercut the coal face. The machine weighs less than 200 lbs and is operated with two handcranks, one to feed the auger bit into the mine face and one to move the auger assembly laterally along a rack-and-pinion positioning device. The unit is 16 in. in height and can be operated in seams as narrow as 20 in. **Circle No. 79.**

Vibrating Conveyor

A natural frequency vibrating conveyor with a variable stroke positive drive has been developed by *Stephens-Adamson Mfg. Co.* The variable stroke feature provides variable conveying speeds from zero to maximum. Speed is controlled accurately regardless of conveyor length or capacity handled, since the eccentric drive is positive and will not dampen out or lose stroke. Either remote or manual controls for the variable stroke drive are available, and adjustment of the drive can be made even during operation of the conveyor. Another feature of the conveyor is dynamic balancing whereby energy generated in the low amplitude vibrating coil springs is reclaimed and used to help maintain conveyor action. **Circle No. 80.**

Beryllium Analyzer

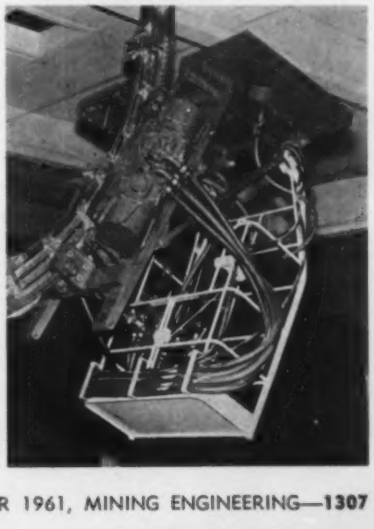
Kleber Laboratories, Inc. has introduced a new beryllium analyzer for laboratory use. Utilization of a radioactive antimony source provides the gammas which are necessary to initiate the reaction. The resultant neutrons are then counted. Five mg of BeO are readily detectable in a 100-g sample. Price of the unit: $6750. **Circle No. 81.**

Air Leg Drill

Machinery Center, Inc. has introduced the "Long Tom" 9-ft retractable air leg. This unit consists of a balancing air cylinder and an extendable air cylinder. By adjusting a four-way pressure valve which regulates air in the balancing cylinder, air supports the rock drill. The extendable air cylinder maintains the drill point in constant contact with the ore. **Circle No. 82.**

Raise Climber

The STH-3K raise climber developed by *Alimak Corp.* has a two-motor drive which can lift a 2000-lb live load. A curved guide rail permits the raise inclination to be altered. The unit has double chain drives which operate through worm gears and spring-relieved internal gears to three external drive pinions. Rated speeds of the machine are 40 to 50 fpm in ascent and 60 fpm in descent. **Circle No. 83.**



DATA

FOR MINE AND MILL

(101) "STUDY OF GRINDING-BALL WEAR EMPLOYING A RADIOACTIVE-TRACER TECHNIQUE" is the title of an AIME Transactions reprint available from *The Coates Steel Products Co.* The paper deals with relative effects of certain chemical and physical properties on the wear resistance of various types of grinding balls when grinding cement. The radioactive-tracer technique was used in separating test balls from the rest of the mill charge and in sorting the different types of balls.

(102) PORTABLE PLANTS: A complete line of their systemized portable crushing and screening plants is outlined in Bulletin CC-1-61 released by *Universal Engineering Corp.* Graphically illustrated with descriptions, the bulletin shows how these units, when balanced into a systemized plant, will provide greater production and profit.

(103) VIBRATING FEEDER: A brochure describing the new "Solid Stroke" variable rate mechanical vibrating feeder has been made available by *Stephens-Adamson Mfg. Co.* The feeder is reportedly the only vibrating feeder offering a solid drive connecting rod controlling amplitude of stroke and insuring constant flow of material with any setting, regardless of varying headload. It is also reported to be the only vibrating feeder that takes full advantage of the principle of natural frequency over its full operating range.

(104) BELT MAINTENANCE WALL CHART: A wall chart pointing out various ways to cut down on costly wear and tear of conveyor belting through proper maintenance procedures is available from *Hewitt-Robins.* Subjects covered are: storage, record keeping, alignment, impact idlers, drive pulley lag, loading chute, skirting rubber, automatic switches, inspection schedules, lubrication and repair.

(105) PIC-A-PUMP CATALOG: *Allis-Chalmers'* expanded pump line is described in a new 1008-page catalog. Engineering data are conveniently arranged for selection of centrifugal, axial or mixed flow pumps best suited to individual and specific applications. The information permits ready "engineering" of the pumping units as well as selection of the materials of construction needed.

(106) FLOTATION CELL: *Heyl & Paterson, Inc.* has released Brochure 861 describing their Cyclo-Cell for froth flotation. Its outstanding feature is the simplicity of design achieved by elimination of all moving parts. Introduced only recently into several coal and non-metallic preparation plants, this unit has already earned a reputation for dependable, low-cost operation and superior performance with high recovery rate of a quality product.

(107) TRAC DRILL: The TDM-B2 trac drill, a boom-mounted crawler drill for underground hard rock mining, is described in a four-page bulletin offered by *Joy Mfg. Co.* All operating functions of the unit—tramming, positioning and drilling—are performed by one man from a conveniently located control station. The machine drills toe holes as low as 18 in. or horizontal holes as high as 13 ft, with a lateral drilling range of 15 ft.

(108) DO-IT-YOURSELF BUCKET ELEVATORS: A bulletin offered by *The Bucket Elevator Co.* describes the new design of bucket elevators shipped from stock in kit form for field assembly. The "BUCK-EL-LIFT-IT-KITS" are centrifugal discharge bucket elevators for elevating bulk materials. All components are pre-engineered, shipped boxed ready for on-the-job assembly. Simple instructions accompany shipment.

(109) PNEUMATIC DRILL MANUAL: *Mission Mfg. Co.* has issued a 30-page booklet (Operation and Maintenance Manual) describing their Hammerdril, a pneumatically operated, bottom hole drill that combines the percussive action of cable tool drilling with the rotary action of rotary drilling.

(110) "ACID PULP HANDLING AT ELDORADO'S PORT RADIUM OPERATION" by R. R. Hoffman and R. J. Tremblay, a report on recent developments at Canada's first uranium acid mill, has been reprinted from Canadian Mining and Metallurgical Bulletin and is available through *Dorr-Oliver Inc.*

(111) CONCRETE GUN RIGS: *Ridley and Co., Inc.* has issued a bulletin describing their concrete gun rigs. Such features as paddle mixer, material elevator, secondary paddle mixer-hopper, C-3 gun and hose storage are discussed.

(112) TESTING SIEVES MANUAL: The *W. S. Tyler Co.* has announced the availability of the 1962 edition of its 48-page handbook, "Testing Sieves and Their Uses". The handbook carries complete specifications on the new U.S. Sieve Series ASTM E-11-61 (published as a final standard on September, 1961), comparison of U.S., Tyler and principal foreign Standard Sieve Series and a list of foreign standards using the fourth root of two systems of sieve openings. In addition, the handbook contains information on selection of testing sieves for size analysis of crushed, pulverized or screened products or any study of particle size distribution with latest data on U.S. and International standards for sieves.

(113) NOISE CONTROL: *H. H. Scott, Inc.* has issued a new booklet, "The Why and How of Noise Control," which discusses fundamentals of industrial noise control. The 16-page booklet shows how to set up a noise control program to achieve safe and efficient working conditions. The equipment needed in setting up this kind of program is also discussed.

(114) MACHINERY INVESTMENT ANALYSIS: A 14-page brochure on manufacturing research and engineering has been released by *Designers for Industry, Inc.* Discussed in the brochure are case histories on 1) setting up new manufacturing facilities, 2) revising antiquated production facilities, 3) deciding what operations should be automated for greater return and 4) analyzing the investment for an assembly machine.

(115) DIRECT-MOUNTED MOTORS FOR VIBRATING SCREENS: How the direct-mounted motor on the "Low Head" screen saves headroom, reduces belt cost and wear, and simplifies maintenance is described in a bulletin released by *Allis-Chalmers.* Diagrams illustrate how the direct-mounted motors eliminate overhead superstructures for mounting motors, gantry-type motor supports and belt tensioning and alignment problems.

(116) CONVEYOR BELT ENGINEERING: With the aid of a grant from *Hewitt-Robins,* Pennsylvania State University engineers have conducted an investigation to develop techniques to analyze separately the power consumed by troughing idlers, return idlers, return strand of belting and the carrying belt (both loaded and unloaded). The formula, developed as a result of the two-year study, has been incorporated with other comprehensive data in a booklet available from *Hewitt-Robins.* Complete statistical data and tables for calculating, engineering and selection of conveyor belting are also included in the publication.

INSERT: Circle No. 28 on the reader service card. ►

AIME also publishes: JOURNAL OF METALS (monthly), JOURNAL OF PETROLEUM TECHNOLOGY (monthly), SOCIETY OF PETROLEUM ENGINEERS JOURNAL (quarterly), TRANSACTIONS OF THE METALLURGICAL SOCIETY (bimonthly).

THE DRIFT OF THINGS

as followed by Paul C. Merritt

To William Henry Seward, Controversy came at 2¢ an acre. In the face of widespread public apathy and antipathy, disregarding the almost total damnation from the leading periodicals of the times, and working within a very hostile domestic political climate, Seward, our then Secretary of State and an apostle of the theory of "Manifest Destiny", almost single-handedly rammed through Congress a treaty which brought us the Bering Sea Islands, the Aleutians, and the Alaskan mainland. The time was 1867; the land covered 586,400 sq miles; the cost was $7,200,000.

Alaska, as we know it today, was born and raised in controversy. It will undoubtedly mature from its present stage to that of our other states in time, but their is little question that this growth will not be without further debate. Ever since Czar Alexander II first broached the idea of selling Alaska, then called Russian America, in 1854, the area has been embroiled in one argument or another. First, the Czar's military and political advisers voiced objections, but the time-tested Russian institution of Despot's Rule ended such criticism. When word was passed that we were considering such a purchase in 1854, and then again in 1866 and 1867, the American politicians found that their opposition to the idea was as popular then as the subject of income tax reduction is today. One must wonder how Seward and his small group of supporters in Washington succeeded in their endeavor to buy Alaska, but when a person finds out about the extensive wining and dining of key members of Congress, the probable political trades, and the wonderful tool of calling all Senators from their beds to convene in the Senate Chamber at midnight to hear Seward argue the merits of his case, he can realize how the opposition might become dissipated.

So finally we bought Alaska, Seward retired, tempers cooled, and the territory accepted as part of our country.

Then came the question of Statehood. Over the years, Alaskan citizens had shown a preference for the Democratic Party, and the presence of two additional Democratic Senators in the usually closely balanced Senate was not considered particularly desirable from the Republican standpoint. And so "Statehood for Alaska" kept cropping up in the various legislative gatherings with final action always somehow postponed.

In the final analysis, Alaska can thank Hawaii for statehood. Since Hawaii was nominally Republican in its voting patterns, the joint acceptance of the two Territories would preserve the "balance" which existed in the Senate, and it was to this apparent trade between the two political parties that many observers believe helped ensure the addition of two new states to the Union.

Today Alaska is undergoing another controversy, but of a different type. It concerns its future, or more precisely, its future contributions to the American economy. Among members of the mining industry, it is not hard to get radically conflicting opinions on mining's future in the 49th State. The crux of the arguments which are put forth, both pro and con, concerns the economics of prospecting, mining and marketing mineral products from the state. As the reader goes through the articles in this issue of MINING ENGINEERING, he will note this recurring theme in many of them. Depending on whether expenses can be lowered (or sufficient large, high-grade bonanzas found) hangs the *immediate* future of Alaska's mineral industry. The long range outlook is dependent on something else.

Let's look at the major factor affecting near term development, that is, costs. One of the most enthusiastic boosters of Alaska, yet a man with a realistic outlook on the problem, is James A. Williams, Director of the Division of Mines and Minerals in Alaska. At the Mining, Minerals and Petroleum Conference held in College (Alaska) on April 18, 1958, Williams discussed the vicious circle of costs and hit the proverbial nail on its head when he said, "Except for permafrost, there are probably no mining problems in Alaska that do not exist in the (other) states. Alaskan problems are merely magnified, extended, more time-consuming, and more expensive. It seems to me that the extra expense and most of the difficulties of doing business in Alaska go in the proverbial vicious circle. The high cost of doing anything in Alaska is caused mostly by high-priced labor. The high wages are caused by the high cost of living. This is due to the high cost of transportation. Transportation is high mostly because of one-way freight and not enough of it to interest much competition. The small amount of freight is due to Alaska's small permanent population, which is due to the lack of basic industrial growth, which is due to the high cost of doing anything in Alaska. . . We feel that if Alaska is ever to have a permanent and stable economy, it will have to be by means of basic industry closely connected with her natural resources. We feel too, that the main key to reversing the merry-go-round is transportation. Reduction of shipping costs would do more to bring all costs down than any other one item in the circle." Alvin Kaufman, mineral economist with the Bureau of Mines, reports on this all-important facet of Alaskan mining operations in his article starting on page 1343.

Regardless of how optimists or pessimists analyze the potential development of Alaska, they will agree that there is no quick solution to the high costs of operation. More than any other factor, these costs will hinder the growth of the mining industry for years to come.

Perhaps that last statement should be qualified by the additional phrase, "unless unforeseen events occur in the world." Any general prediction of this State's future industrial growth must necessarily entail some consideration of the present political turmoil on this globe. As Charles Herbert states in his article "Prospecting and Politics," regardless of what happens in other countries, Alaska *is* "politically accessible." This factor could gain rapidly in importance if we find more and more of our overseas mining properties subjected to nationalization policies. It is this writer's guess that the future of mining in the 49th State will be determined ultimately by the internal actions of other nations.

Americans may little note nor long remember their Secretaries of State, but if and when Alaska begins to feed is resources into our mills and plants, it will be due indirectly to the foresight of Seward.

* * * * *

This issue dwells on the mining industry in Alaska today, and as the reader will note, the various subjects included in this Regional Review cover a lot of ground. But one subject that has received only passing comment is the life-and-death struggle of Alaska's coal industry, and it would be remiss not to elaborate on this problem here.

In this state, as elsewhere in the U.S., the future of coal is being seriously threatened by the oil and gas industry. At the present time, this conflict is centered around Anchorage where coal from the nearby Matanuska field meets the gas pipelines from the Kenai Peninsula head-on, both of them vying for the military and civilian markets open to them in that city.

There are two basic elements of this competition that is playing havoc with the coal producers. First, since the Government classifies coal as a "fuel" and natural gas as a "utility", coal companies can only make a one-year contract with their principal consumer, the Military. On the other hand, the "utility" by virtue of its classification is permitted to negotiate the more favorable ten-year contracts with this particular arm of the Government. Secondly, since the gas is a byproduct from the Kenai oil fields, its cost is so low that Matanuska field operators cannot hope to compete with it price-wise.

The squeeze is more than apparent when one talks to owners of these coal mines. Since the arrival of the pipeline in Anchorage from the Kenai last year, the coal companies have lost, or are in the process of losing, a substantial portion of their civilian market. Now the gas industry is trying to capture the military market which normally consumes more than 70% of the coal from the Matanuska field. The upshot of this situation is that the coal companies are now existing on a year-to-year basis with the omnipresent spector of natural gas standing by to apply the *coup de grâce*.

Little has been heard about this problem outside of Alaska, but the coal producers in Anchorage now have a vocal leader in Alan Horton, general manager of the Evan Jones Coal Co. He has been busy presenting his case to various coal industry groups as well as to government officials, and it will be both interesting and important to watch his success in this matter.

* * * * *

As is so often the case with any large project, words of appreciation are clearly inadequate to acknowledge the work done by the many people involved. But without words, there would be no review of mining in Alaska nor would the editors of MINING ENGINEERING be able to convey their profound gratitude to the authors. Only through their ready cooperation and generous contribution of time and energy in preparing these articles has this Regional Review been possible. It has been a great pleasure, in the truest sense, to have worked with them.

In addition to our authors, we wish to thank Kevin Malone at the Bureau of Mines in Juneau who undertook the task of initiating and expediting the various descriptions of operating properties contained in this issue. Special acknowledgment must also go to Alvin Kaufman who not only wrote the article entitled "Economics of Mining in Alaska", but who was also instrumental in the development and culmination of this regional review.

ALASKA: REGIONAL REPORT

INTRODUCTION

To Americans, Alaska occupies a unique position, both geographically and historically. The only integral portion of the United States lying in the sub-Arctic and Arctic regions of the Earth, the early remoteness and climatic conditions effectively combined to impede the economic development of this area. Although Alaska has been a part of our Nation since 1867, its mining industry is still at that stage of development which characterized the West 100 years ago when miners concentrated on high-grade lodes and rich placer deposits.

Since World War II, however, there has been a noticeable increase of interest in the raw materials of the North. This concern has been most noticeable in Canada, Scandinavia and Russia, but it has been, and is being shown in Alaska.

To the American mining industry, the potential importance of this State can be summed up by the question, "Can Alaskan mining compete successfully with those of other states and countries?" The answer revolves about the vital factors of geography, economics, and the political turmoil of the World.

These aspects are among those discussed on the following pages in a series of articles by Alaskans and non-Alaskans alike. We invite you to read "Alaska: Regional Report."

GEOLOGY AND ORE DEPOSITS OF ALASKA

by GORDON HERREID

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Outline of the Geology of Alaska

The geology of Alaska can be described in various ways. The least subjective would be to describe the rocks and show a map of the major geologic units. This is a little like describing a city by use of a telephone directory—complete, but hard to remember. Instead, an attempt has been made to trace the evolution of the geology, relying as much as possible on tectonics to tie the parts into a whole. This approach is more applicable to relating the regional geology to the ore deposits because both are the outcome of a single history.

The surface of the earth, present or past, is described by its physical geography. Successive geographies are often linked by a common tectonic pattern so that large areas remain for long periods in a single category, such as a miogeosyncline or an island arc belt, which characterizes them in a general way. Superimposed on all the smaller changes in geology that produce the multitude of beds and formations are a few major changes of the tectonic picture which occur rapidly enough to provide major time divisions. In this description of the geology in Alaska, three major changes in Paleozoic and later time have been used to divide the geology into four fairly cohesive periods. In describing the various rocks, emphasis has been on those features which indicate the contemporary geography.

Editor's Note: For reference, see USGS *Geologic Map of Alaska* (1957), compiled by J. T. Dutro, Jr., and T. G. Payne.

Major geologic features. Southeastern Alaska not shown.

PRECAMBRIAN

Schistose rocks occur in many of the mountain and upland areas of Interior Alaska. In this general description of the geology of Alaska, it has been assumed that the formation of schists and granites occurred either in the Precambrian or during the Laramide orogeny. Potassium-argon dating and more detailed structural mapping will very likely modify this interpretation. Where these basement rocks have been metamorphosed in Precambrian time, they have a Precambrian stratigraphic significance, but if the schist is dynamically related to younger orogenic periods, they have structural but not stratigraphic significance. The recognition of the role of metamorphic rocks in the history of a region is of primary importance to understanding the relation of ore deposits to the regional geology.

The best known area of metamorphic rocks is the Yukon-Tanana area, which is underlain by the Birch Creek schist. This schist unit has been dated as Precambrian on the basis of the comparison of its lithology and metamorphic grade with unmetamorphosed pre-Middle Cambrian rocks. However, the two rock formations are separated by the major tectonic lineament of the Tintina Trench at the town of Eagle and have entirely different histories, so that this age cannot be regarded as secure. Age-dating work and mapping now in progress should give a clearer view of the early history of this area.

EARLY PALEOZOIC

In Southeastern Alaska, pre-Middle Devonian Paleozoic rocks are typified by an active tectonic history as shown both by unconformities and by deposition of "spilled in," sparingly-fossiliferous, unsorted, graywacke-type sediment, largely derived from volcanic islands within the area. Andesitic and basaltic flows, breccia and tuff are common. Limestone and chert are less common and probably represent times when no land was emergent. This environment of deposition is typical of eugeosynclines. At the northern part of Prince of Wales Island, massive Silurian limestone interbedded with lenses of conglomerate up to 1500 ft thick occur. Boulders in this conglomerate are up to 2 ft in diameter and usually include some granitic types. In Southeastern Alaska all the systems except the

Mississippian include conglomerate, but only the Silurian contains granitic clasts that cannot be referred to Mesozoic intrusives. This formation is overlain with angular unconformity by Middle Devonian rocks. It seems probable that the granite is locally derived and is about the same age as the associated deformation, so that the pre-Middle Devonian unconformity probably represents a period of orogeny with accompanying granitic intrusion.

North of the Alaska and Aleutian Ranges, the early Paleozoic rocks are lithologically different and were deposited in a different geographic province. Sufficient outcrops of these rocks are available to roughly outline this province and determine how long it lasted. In the area from the Kuskokwim to the Nation River district, lower Paleozoic rocks are known in a number of places. In the Nation River district, near the Canadian Border north of the Yukon River, shale and carbonate rocks are found in a conformable (?) sequence from Middle Cambrian to Mississippian. A Lower Devonian hiatus corresponding to the Southeastern Alaska pre-Middle Devonian orogeny is present. In the White Mountains, 50 miles north of Fairbanks, Silurian-Devonian limestone overlies Middle Ordovician basic volcanics at least 2000 ft thick which were deposited in a near shore environment. These are the only volcanics known in the Ordovician outside of Southeastern Alaska and may represent the edge of a tongue of volcanics extending from a southern source into the eugeosynclinal belt.

Along the southeastern edge of the Ruby geanticline, near McGrath, a great thickness of calcareous rocks of Ordovician, Silurian, and possibly Devonian ages is present. In the area of the Goodnews Arch and Central Kuskokwim, carbonates of Silurian and Middle or Late Devonian ages are present. These beds are separated by a hiatus and the succeeding formations are eugeosynclinal. This represents a major change at the end of the Devonian in this area. The southernmost outcrops of lower Paleozoics in central Alaska have been exposed by uplift along the Alaska Range. Limestone and shale of Middle Ordovician age and at least 2000 ft thick occur at the west end of the Alaska Range. Here too, the lower Paleozoics are succeeded by younger rocks of different character, with the Middle Devonian consisting of thousands of feet of conglomerate, slate, limestone and chert. In the Brooks Range the Skajit limestone, which has long been regarded as Silurian, has recently been upgraded to the Middle Devonian (Brosgét', 1960). The Skajit unconformably overlies metamorphic rocks which have not been well described in the literature. On the Seward Peninsula, Silurian limestone is present in the northwestern area.

All of these nonvolcanic, carbonate-shale rocks were deposited on the shelf at the edge of the continent which lay to the north in the vicinity of the Brooks Range. There was volcanism only at the southern edge of the area. Deformation in the eugeosynclinal belt to the south, which produced angular unconformities there, only produced disconformities here. This is a typical miogeosynclinal area. The most widespread hiatus and period of unconformity and possible granitic intrusion in Southeastern Alaska preceding the change from lime rocks to eugeosynclinal rocks in the Goodnews Arch-Central Kuskokwim-Alaska Range area were pre-Middle Devonian, and this period of emergence and eugeosynclinal folding has been taken as the turning point. In the miogeosynclinal areas the next succeeding formation was laid down by the advance of the sea across a land of low relief, and the first rocks deposited were limestone and dolomite. The turning point in the evolution of the miogeosynclinal region was a gentle one.

LATE PALEOZOIC

The change from an amagmatic shelf to a mobile volcanic belt during middle Paleozoic time occurred over a great area along the southern edge of the middle Paleozoic miogeosyncline. The area where the change is best exposed is that of the Goodnews Arch where 5000 to 10,000 ft of early Paleozoic carbonates were succeeded by 15,000 to 30,000 ft of eugeosynclinal siltstone, graywacke, volcanics and limestone of the Gemuk Group. The change was fundamental, as this area received marine graywacke-type sediments until the end of the Mesozoic time.

In the eastern part of the Brooks Range, miogeosynclinal conditions persisted during late Paleozoic time. Up until the end of Triassic time the post-Lower Devonian sediments of northern Alaska were of miogeosynclinal type deposited during periodic uplift and subsidence of a continental region located to the north. The retreat of the low-lying Pennsylvanian landmass before the generally advancing seas of the Permian and Triassic represented the final subsidence of the continent to the north. This continental area has been the site of the Arctic Ocean since that time. Uplift to the south and sinking of the Colville geosyncline is indicated by the conformable deposition on the Triassic lagoonal sediments of a southward coarsening wedge of conglomerate, graywacke and shale during Lower, Middle and Upper Jurassic time. The miogeosyncline was slowly becoming more mobile. Northward migration of folding to the area just north of the Brooks Range by the end of Jurassic time is indicated by the presence of an angular unconformity between the Jurassic and Cretaceous formations in this area; only a disconformity exists further north. During Cretaceous time a wedge of clastic sediments containing up to 20,000 ft of conglomerate, sandstone and shale was deposited on a marine shelf north of the Brooks Range. The formation of the Ancestral Brooks Range during Cretaceous time was the culmination of the orogeny. No marine sediments were deposited after Cretaceous time.

The location and nature of the boundary between the Brooks Range miogeosynclinal belt and the Gemuk eugeosynclinal belt is little known. Northeast of the Gemuk area, scattered rock formation along the Aniak-Ruby geanticline are correlative with Gemuk Rocks. On the Seward Peninsula, Permian (?) greenstone indicates possible eugeosynclinal conditions in that area. On Ruby Creek just south of the Brooks Range, Upper (?) Devonian basic volcanics are present. In the Rampart-Livengood area, the Mississippian rocks consist of basal chert conglomerate and volcanics, limestone and shale higher in the section. The section is similar to that of the Mississippian in the Brooks Range except for the presence of volcanics. The sediments are allied to the miogeosyncline and the volcanic flows present suggest that this area may be one of interfingering of miogeosynclinal beds from the north with eugeosynclinal beds from the south. North of Eagle, about 5000 ft of continental sedi-

ments of Pennsylvanian (?) age are present. Elsewhere in Alaska the Pennsylvanian uplift is represented by only a disconformity. These are overlain by Permian limestone and Upper Triassic limestone and shale, including oil shale. Following a Jurassic hiatus, marine clastic sediments grading upward from shale to sandstone and fine grained conglomerate were deposited during Early Cretaceous time. This succession is very similar to that north of the Brooks Range. In the area around Rampart, the Lower Cretaceous is composed of quartz sandstone. A straight line drawn west from Eagle to the town of Galena and thence possibly north of the Seward Peninsula approximates the boundary between the areas of mio- and eugeosynclinal sedimentation at this time if the volcanics are allowed to extend into the miogeosynclinal for some distance. Triassic time brought the beginnings of changes which led to the differentiation of the area into uplifts and troughs in the Mesozoic Era.

East of the area of the Gemuk Group on the Goodnews Arch, the best known area of late Paleozoic eugeosynclinal rocks is in the eastern part of the Wrangell Mountains. The oldest rocks present are several thousand feet of metamorphosed basalt and tuff of the Mississippian Strelna formation. In the Chitina Valley, these rocks are unconformably overlain by 5000 ft of possibly subaerial Nikolai greenstone flows which are Permian in their basal part, and which in turn are overlain by apparently conformable Upper Triassic Chitistone limestone. Immediately to the north in the White River-Wrangell Mountains area, however, the Nikolai greenstone is missing entirely and the Chitistone limestone overlies the middle of a folded section of Permian basalt and tuff interbedded with marine limestone, shale and sandstone which presumably underlies the Nikolai. The Nikolai greenstone has generally been considered to be of latest Permian in age, possibly extending into the Triassic because it is conformably overlain by Upper Triassic limestone. It seems possible that the White River Permian and the Nikolai are the same age and that the rocks on White River were deposited in the southern part of a shallow marine basin with the Nikolai greenstone being their subaerial equivalent adjacent to the Basin. This would give a single post-Strelna section of Permian greenstone overlain disconformably by Upper Triassic limestone. The common association of Upper Triassic limestone conformable on Permo-Triassic greenstone may be due to the low topographic relief of much of the volcanic landmass which was invaded by the Upper Triassic sea. The Permian greenstone marks the end of eugeosynclinal conditions in this area. The fine-grained sediments throughout the late Paleozoic indicate low topographic relief. The eugeosynclinal conditions were highly magmatic in this area but not very mobile.

The Wrangell Mountain-White River area has been a positive area intermittently for a long time. Just north of the White River drainage, Devonian volcanics occur in an area of mostly Permian rocks, indicating non-deposition or erosion of the Mississippian. As noted above, an unconformity also exists below the Upper Triassic in the White River area, and the lack of later Mesozoic and Tertiary marine sediments indicates the positive tendencies of the area since that time.

The Mississippian, Permian and Triassic rocks of the Wrangell Mountains crop out along the south side of the Alaska Range and the northern part of the Talkeetna Mountains without gross lithologic change until they are lost under younger rocks. To the south along both sides of Cook Inlet, Upper Triassic limestone and chert is underlain conformably by greenstone correlative (?) with the Permian greenstone.

In the Gemuk area, deposition during each of the periods appears to have been of similar lithologic character to that in the area south of the Alaska Range, except that much more siltstone was deposited and Triassic (?) volcanics are present. On the north side of the Alaska Range, several thousand feet of rhyolite was deposited during Mississippian (?) time indicating that this area had a separate history at the early date. In Southeastern Alaska, chert, limestone and quartzite were deposited in Mississippian time; conglomerate, limestone, sandstone and volcanics in Permian and Upper Triassic. The lack of graywacke suggests that the late Paleozoic was tectonically quiescent in Southeastern Alaska.

In summary, by Mississippian time the northward encroachment of conditions of mobility and volcanism into the southern part of the miogeosynclinal area resulted in deposition of eugeosynclinal sediments on older carbonate rocks. Details of the paleogeography in this belt are little known but most of the sediments were derived locally from volcanic islands in the belt. Moderate relief in the area is indicated by the prevalence of siltstone over graywacke, and periods of nondeposition of clastics are indicated by limestone and chert. South of the Alaska Range relief was lower and volcanics were widespread, particularly in Permian time. No sediments of known Pennsylvanian age are present. Deposition of widespread Upper Triassic limestone marked the end of eugeosynclinal conditions south of the Alaska Range, but in the Gemuk area eugeosynclinal conditions lasted until the end of Lower Cretaceous time.

MESOZOIC SOUTH OF THE YUKON RIVER

In Southeastern Alaska andesites were deposited in Upper Triassic time. Gabrielse and Wheeler (1961) believe that the axis of the Coast Range in Southeastern Alaska was a belt of volcanic islands. It seems unlikely that this belt extended into western Alaska during the Triassic, but the Lower Jurassic volcanics that extend across the northeastern Aleutian Range and Talkeetna Mountains probably represent a Jurassic volcanic island arc. The Lower Jurassic lavas and pyroclastics of intermediate composition along the west coast of Cook Inlet and the Talkeetna Mountains give way to fine-grained tuff along the north edge of the belt on the Skwentna River. The volcanic island arc was probably not far from the belt of coarses volcanics. On the south side of this volcanic belt, sandy and shelly near-shore sediments with local conglomerates were deposited from Middle Jurassic to Early Cretaceous time. A narrow seaway existed along the south side of the Talkeetna Mountains during Middle and Late Cretaceous time with sediments deposited from a narrow tectonic belt to the south during Middle Cretaceous and from a larger landmass in the Talkeetna Mountain area in the north during Late Cretaceous time (Grantz, 1960). North of the volcanic belt, along the south slope of the Alaska Range, a great belt of monotonous unfossiliferous graywacke and slate occurs which

ranges in age from Lower Jurassic to Late Cretaceous. This wedge of clastic sediments was poured into this trough (the Alaska Range geosyncline) during the same period that the thick sequence of well differentiated, fossiliferous beds were being deposited on the south side of the volcanic island belt 80 miles to the south. Similarly, south of the volcanic area in the Chugach Mountain area, another great clastic wedge of unfossiliferous "poured in" graywacke and slate occurs in the Chugach Mountains geosyncline. Like the Alaska Range belt, its age has long been a puzzle, but a few Upper Cretaceous fossiles have been found. It is possible that Jurassic rocks are present also. Both of these graywacke belts appear to have been deposited in abyssal trenches, with graywacke beds representing repeated turbidity current flows from the steep slopes. The Mesozoic geography from Prince William Sound to Mt. McKinley contain a foredeep in the Chugach Mountains area, a nonvolcanic tectonic island belt (at least during Middle Cretaceous time) a narrow seaway (interdeep), a volcanic island belt, and finally a back deep in the Alaska Range area. These features are typical of island arc systems.

The Talkeetna tectonic belt extends southwestward to merge with the Aleutian Island chain which is a modern island arc. It extends eastward across the sunken Copper River basin block to the Wrangell Mountains, which have a gross structure similar to the Talkeetna Mountains. The geology of the St. Elias Mountains is not well known, but in Southeastern Alaska this island arc lines up with the Chichagof igneous belt where great uplift since Mesozoic time provides a view of rock formed at depth below an island arc.

The granite on the west shore of Cook Inlet intrudes Lower Jurassic volcanics, and granite pebbles are found in the Middle Jurassic, indicating intrusion at least as early as Middle Jurassic. In the Talkeetna Mountains, Grantz and Jones (1960) have dated the quartz diorite as late Early or Middle Jurassic. To the north in the Alaska Range, granitic rocks are as young as Late Cretaceous. This is another example of the commonly observed progression in age of intrusives across the Sierran mountain belt. In the Copper River area, granitic rocks are post-Late Triassic and pre-Late Jurassic. In Southeastern Alaska, granitic intrusives have commonly been mapped as Jurassic of Cretaceous. Gabrielse and Wheeler (1961) give potassium-argon dates from the Coast Range of latest Permian, Early Jurassic and Middle Jurassic.

The granitic stocks and batholiths from the Chitina River area west have generally sharp, intrusive contacts. In Southeastern Alaska, the west margins of the Coast Range intrusive and the intrusive belt that extends through Chichagof Island are gradational with the country rock through a band of gneiss and metamorphic rock several miles wide. In the gneiss belt numerous inclusions of country rock are oriented parallel to the regional structure. Forbes (1959), in a Ph.D. thesis (to be published by the Alaska Division of Mines and Minerals) on the Juneau area, has shown that the metamorphic grade of the rocks progressively increases from the metamorphosed sediments into the migmatitic gneisses and that in the interior of the Coast Range "batholith," the migmatitic rocks became so mobile that they were locally intrusive. The granitic rocks which compose the eastern margin of the batholith are more potassic than those of the west and are intrusive.

In the Alaska Range, granitic intrusion took place from middle Mesozoic to Late Cretaceous. Marine deposition of graywacke and slate in the Alaska Range geosyncline ended before Late Cretaceous time when deformation of the area produced the nonmarine Cantwell conglomerate. Subsequently the area was eroded to a low relief and the Eocene coal-bearing formation was deposited in local basins. As a result of uplift in later Tertiary time, gravel was deposited in block-fault basins. The great uplift of the Range occurred during Pliocene time (Paine, 1955).

In Southeastern Alaska the cross section from the Chichagof igneous belt to the Coast Range is somewhat similar to that in western Alaska from Prince William Sound to the Alaska Range. The fore and back deeps along the west margins of the Coast Range and Chichagof Island have been filled with Triassic to Cretaceous eugeosynclinal sediments. Apparently, island arcs existed along both the Coast Range and the Chichagof belts, though not necessarily at the same time. Eocene sediments, including coal beds, occur east of the Chichagof belt and Tertiary rhyolite and basalt are present indicating that the Tertiary history is similar to that of other areas in Alaska.

MESOZOIC NORTH OF THE YUKON RIVER

The only known lower Mesozoic rocks between the Yukon River and the Brooks Range are 500 ft of Upper Triassic limestones in the Nation River area. No Jurassic rocks are known to occur in the entire region. It was noted previously that Jurassic time in the area north of the Brooks Range marked the beginning of clastic sedimentation from a southern source and that uplift and deformation extended to north of the Brooks Range by Early Cretaceous time. It is possible that a large area south of the Brooks Range was emergent during Jurassic time.

In the Koyukuk Basin, the Jurassic history is unknown as no rocks younger than Lower Cretaceous are exposed. In the middle of the basin a small dome exposes several thousand feet of Early Cretaceous marine sediments and volcanics, indicating that the Brooks Range was shedding sediments to the south by that time. During late Early Cretaceous to Late Cretaceous time the basin was filled mainly with marine clastics derived from the surrounding topographic highs of the Brooks Range, Seward Peninsula and Ruby geanticline. By the end of Cretaceous time, the basin had shallowed so that nonmarine sediments were deposited, and since that time, no further sedimentation has occurred over most of the area. The Cretaceous sediments in the basin have been strongly deformed.

The Ruby geanticline was the site of late Paleozoic Gemuk Group deposition of eugeosynclinal sediments. The area may have been emergent during Jurassic time, and was certainly so during the Cretaceous. The northward extent of the earlier Gemuk Group sediments beyond the Ruby geanticline is unknown, but the uplift of the Ruby geanticline in Jurassic or Cretaceous time outlined the northern edge of the Kuskokwim geosyncline in approximately its present location. Coarser grained clastic sediments (i.e., graywacke) in the Jurassic and Early Cretaceous parts of the Gemuk suggests that the conditions of orogeny and uplift had begun at that time in this area. The culmination of uplift in

the source areas of the Kuskokwim geosyncline occurred from late Early Cretaceous to Late Cretaceous when 20,000 to 30,000 ft of graywacke, shale and conglomerate of the Kuskokwim Group were deposited. Near the margins of the geosyncline the composition of the rock fragments making up the geosynclinal sediments mirrors to some extent the rock types of the older rocks surrounding the geosyncline. This indicates that the basin outline has not changed much since Cretaceous time. Hoare (1961) considers that some of the rocks near the top of the Kuskokwim Group are nonmarine in origin, as in the Koyukuk Basin. At the Red Devil mine, near Sleetmute on the Kuskokwim River, nearly all the graywacke beds are conspicuously graded, and sole marks typical of graded beds are present. These beds were deposited by turbidity currents, which were probably the principal means of deposition over wide areas in the Kuskokwim and other graywacke-shale filled geosynclines during periods when they were deep and steep sided.

Southeast of the Kuskokwim River, the Kuskokwim formation extends around the end of the Lime Hills geanticline into the Mulchatna River drainage. It has been suggested (Cady and others, 1955) that the Kuskokwim Group and possibly underlying Gemuk Group sediments in this area are the southwest extension of the graywacke-shale sediments of Jurassic and Cretaceous age of the Alaska Range geosyncline. This would mean that the Mesozoic rocks of the Mulchatna River Drainage were deposited in the back deep of the Talkeetna island arc belt.

TERTIARY

The thick accumulations of clastic sediments deposited during the Cretaceous north of the Brooks Range, in the Koyukuk Basin, in the Kuskokwim and Alaska Range geosyncline and in the Chugach Mountains geosyncline mark the culmination of the Jura-Cretaceous orogenies. No important marine sedimentation has occurred since Cretaceous times in these areas. In the areas south of the Brooks Range at the beginning of the Tertiary, these incompetent graywacke-shale beds were folded under conditions of shallow burial.

During Tertiary time the Kuskokwim geosyncline was intruded by rhyolite sheets, and later, basalt flows were extruded. Subsequently, extrusive centers were intruded by quartz monzonite stocks. These stocks are part of a scattered belt of shallow Tertiary granitic intrusives that extend from Goodnews Bay to near Livengood. This belt runs along the southeast side of the Ruby geanticline and extends far out into the Kuskokwim geosyncline. Similarly, a group of Tertiary granitic intrusives lies northwest of the Ruby geanticline, in the Koyukuk Basin.

During most of the Tertiary time, the Interior was topographically low, but several erosion intervals between periods of uplift have left their imprint on the topography. A Miocene erosion surface is preserved in the form of accordant summit levels above a rolling topography developed during Pliocene time. Differential uplift near the beginning of Pleistocene time has rejuvenated this surface in places. Glaciation, which occurred during the later Pleistocene, was restricted to areas in and adjacent to mountain areas.

The Tertiary marks the fourth major tectonic period, which begins with the end of sedimentation in the Cretaceous geosynclines and the folding of their sediments. These areas were consolidated by folding and have not been folded since that time despite differential uplift and subsidence, and intrusion by volcanic and shallow granitic rocks. This brittle behavior is not true of the Tertiary sediments deposited along active tectonic zones. The Tertiary coal-bearing formation and gravel deposited in the Alaska Range and the sediments in the Tertiary Yakataga geosyncline have been folded moderately. The land surface has remained above sea level except near the present coasts. However, the southern part of the Copper River Basin may prove to be an exception.

Large topographic basins are a conspicuous feature of Interior Alaska. They have great importance as possible petroleum areas if they contain thick accumulations of marine Tertiary rocks. Recent aeromagnetic surveys conducted by the USGS (Zeitz, Andresen and Grantz, 1960) indicate that sedimentary rocks up to three or four miles thick occur in Cook Inlet, and its extensions along the Kenai lowland and in the southern part of the Copper River Basin, in Kvichak Bay, and in the Yukon-Kuskokwim Delta. To date, one oil field and three gas fields have been discovered in the Kenai lowland. The Yukon flats, Galena Basin and Selawik Basins do not contain thick Tertiary accumulations. These shallow basins may have formed at the time of block uplifting at the end of the Pliocene.

The greatest Tertiary sedimentation in Alaska was on the seaward side of the Chugach Mountains geosyncline where 25,000 ft of Tertiary sediments accumulated. The latest rocks in the Chugach Mountains geosyncline are Upper Cretaceous. Along the south margin of the geosyncline at the beginning of the Tertiary, these rocks were folded and thrust towards the south and shed clastic sediments into the Tertiary Yakataga geosyncline on their southwest side. At the end of the Tertiary, the Chugach-St. Elias Mountains along with the bordering Tertiary belt were again uplifted and thrust toward the south. This movement is still going on. (Plafker and Miller, 1957). The Yakataga geosyncline is considered a very favorable area for oil exploration.

FAULT TECTONICS

The structural information available on Alaskan rocks is meager. A few major faults are known which seem to be intimately connected with the tectonics of the area. In Southeastern Alaska, a major system of northwest striking faults is present plus other ill defined systems (Twenhofel and Sainsbury, 1958) which make a horse-tail fault system on a gigantic scale. Glaciation has given topographic expression to the faults and make their delineation possible. This fault system is probably a right lateral wrench fault system similar to the San Andreas fault in California (St. Amand, 1957). The right lateral faults in the Chichagof district are probably members of this fault system and the presence of dikes and ore along these faults indicates the possibility that these faults were active as early as Cretaceous time. St. Amand has suggested that the Lynn Canal fault is a continuation of the Denali fault which runs along the Alaska Range and then cuits across the Kuskokwim geosyncline. This major fault is paralleled on the north by the Iditarod fault and on the south by a fault along the south side of the Talkeetna Mountains which St. Amand calls the Lake Clark fault. The Yukon River at the Canadian

border follows the Tintina Trench, which may be a major wrench fault (Gabrielse and Wheeler, 1961, p. 24). The northwest extension of this lineament is problematical. All of these rather enigmatic lineaments have many of the characteristics of wrench faults.

SUMMARY

During the early Paleozoic Era, Alaska was made up of three geographic zones. In the area of the present Arctic Slope lay the stable continent. South of the Continent in the area now between the Brooks Range and perhaps, the Talkeetna Mountains, lay a slowly subsiding amagmatic miogeosynclinal belt where mainly limey and muddy sediments derived from the continent accumulated. South of this belt lay the magmatic eugeosynclinal area where rapid sedimentation derived from basic volcanic rocks on tectonic islands prevailed. The eugeosynclinal belt migrated north into the miogeosynclinal area at the end of Devonian time. By the end of the Paleozoic time, the eugeosyncline extended as far north as Eagle in the east, and north of the Seward Peninsula in the west. This period reached its culmination in the floods of basic volcanics in Permian time. The Mesozoic Era began with the retreat and final sinking of the northern continent in the area now occupied by the Arctic Ocean. In Jurassic time the Laramide orogeny began, with the uplift of mountain ranges along the Talkeetna island arc belt, the Seward Peninsula and in the area south of the Brooks Range. Intrusion of granitic bodies in the Talkeetna island arc belt took place at this time. North of the Brooks Range nonvolcanic sediments were deposited on a slowly subsiding shelf during the Jurassic and Cretaceous periods. The Talkeetna island arc had deep trenches along both flanks until Late Cretaceous time. The Ruby geanticline and the Yukon-Tanana areas were probably emergent at this time, as was the Seward Peninsula. The culmination of the orogeny occurred from late Early Cretaceous to Late Cretaceous time when granite was intruded in the mountain ranges and great wedges of clastics were deposited along their flanks in the Colville geosyncline, Koyukuk Basin, Kuskokwim geosyncline, Alaska Range geosyncline and Chugach Mountains geosyncline. The Cretaceous sediments were folded before Eocene time. During the Cenozoic, Alaska remained above sea level for the most part, deformation has been by subsidence and elevation of blocks rather than folding, basic and acid volcanics have been extruded, and shallow granitic stocks have been intruded. At the beginning of Pleistocene time much of Interior Alaska was uplifted and glaciation took place in many of the mountainous areas.

Geologic Setting of Selected Ore Deposits

The present stage of knowledge of the geology of Alaska makes possible a fairly accurate description of the major crustal movements that are responsible for island arc belts, eugeosynclines, etc. These are useful as a means of systematizing geologic history. For the purposes of economic geology the more local contact phenomena are of more immediate importance, as they produce openings and thermal gradients which are the how and the why of ore geology. Thus the Alaska Juneau orebody appears to have formed at or near the contact between the deforming metamorphic belt of the Coast Range and the more competent rocks beyond. The Kennecott mine is associated with copper-bearing greenstone along the tectonic zone that was active between the Talkeetna island arc belt and the Chugach Mountains geosyncline.

Many mines which are located along minor structures are, nevertheless, associated in a general way with major ones. The Nabesna mine, the Valdez Creek gold district and the Golden Zone mine are located along the south side of the Alaska Range and north of the Talkeetna island arc belt. They are different types of deposits which share the same belt. On strike, tectonically, with the low temperature Kennecott Copper mine is the Willow Creek district with intermediate temperature gold veins in a quartz diorite country rock. These ore deposits may only be related to the extent that they occur along active tectonic lineaments.

In the Kuskokwim region the Iditarod fault zone roughly parallels the south side of the Ruby geanticline. Most of the mines in the region fall within a few miles of this fault, and it may have had a role in the emplacement and/or brecciation of the quartz monzonite stocks and be thus indirectly responsible for the ore.

On a smaller scale the Red Devil cinnabar deposit has been localized along a wrench fault (see page 1337). Such structures on the individual mine scale are of more importance to development of a mine than for regional prospecting.

DESCRIPTIONS OF ORE DEPOSITS

Southeastern Alaska: The principal mineral production in Southeastern Alaska has been from the mines of the Juneau area, mainly from the Alaska Juneau mine and its predecessors at Juneau, and from the Treadwell group of mines one mile to the west. Together, these mines have produced $148 million in gold from 1885 to 1944. At the Alaska Juneau, the gold occurs in a wide zone of small quartz veins in a zone of movement in black phyllite. Older pre-movement quartz veins are present but are said to have lower gold values. Other minerals in the quartz veins are pyrrhotite, galena, sphalerite, arsenopyrite, pyrite, chalcopyrite and ankerite. The gold values tend to be directly related to the amounts of galena and sphalerite present. The mines of the Juneau area are part of the Juneau Gold Belt, a province over 120 miles long in which ore deposits similar to those in the Juneau district occur. Of the location of the mines in this belt, Brooks wrote in 1910 that they "occur in a belt

The Red Devil mine, situated between Kuskokwim River and Barometer Mtn., is near center of Alaska's mercury belt.

skirting the mainland of Southeastern Alaska and usually separated from the granitic batholiths by a zone of crystalline schists a mile or more in width." In the extensions of this belt north and south of the Juneau Gold Belt, gold values are often subordinate to those of copper, lead or zinc.

Seventy-five miles southwest of Juneau along the west side of the Chichagof igneous belt, gold deposits are similarly situated in respect to a granitized belt of igneous and metamorphic rocks. The veins occupy right lateral wrench faults which appear to be of about the same age as the main igneous belt in the area. The ore deposits in the Chichagof district are closely analogous to those in the Juneau Gold Belt in mineralogy, in location, in respect to regional geology, and in conditions of deposition. Ore deposition in these two belts occurred just outside of granitized zones and was associated with movements that were probably part of the regional wrench faulting. There is evidence that these movements occurred while the plutonic rocks were still hot and provided the openings necessary for the deposition of ore.

Base metal deposits of similar mineralogy to the Juneau Gold Belt occur in areas of metamorphic rock in the Coast Range "batholith."

West of Ketchikan, on Prince Wales Island, a number of copper-iron deposits have long been known. These deposits have been mined for copper in the past and are of interest at present because of their iron content. They are contact metamorphic replacement deposits which occur in or near limey beds in the volcanic bedrock near the contacts with intrusive granitic stocks. The ore consists mainly of magnetite and chalcopyrite and is found in areas where much orthoclase has been introduced. It contains no titanium. This is an area of Paleozoic rocks exposed in the geanticlinal belt that parallels the Coast Range along its west side.

A series of massive ultrabasic bodies occurs along the west side of the Coast Range batholith. These rocks are apparently intrusive and in places segregations of titaniferous magnetite are sufficiently rich to be of economic interest (see R. J. Lund's article, page 1351). The examples of most economic interest are at Klukwan, near Haines; Port Snettisham, south of Juneau; and Union Bay, north of Ketchikan.

Nickel-copper deposits are associated with gabbroic and noritic intrusive bodies in a number of places in Southeastern Alaska. The ores consist mainly of pyrrhotite and a little pentlandite and chalcopyrite. Most of these deposits occur along the Chichagof belt and are associated with basic intrusive bodies that are younger than the Mesozoic granitic intrusives. One deposit is known on Admiralty Island, in the anticlinal belt of Paleozoic rocks west of the Coast Range. Pyrrhotite bodies associated with dioritic rocks more acidic than gabbro do not carry significant nickel. No nickel deposits are known along the west margin of the Coast Range where the Juneau Gold Belt occurs.

On the east side of the Coast Range the granitic rocks which are exposed have formed at shallower levels in the crust and are thus intrusive into the country rock. The ore deposits in this belt often contain scheelite and a high silver content. For the most part these deposits are in Canada, except at Hyder where Alaska extends farther eastward. Here, at the Riverside mine, scheelite, galena, pyrite, tetrahedrite, pyrrhotite, chalcopyrite, sphalerite and native gold occur in granodiorite of Jurassic or Cretaceous age.

South of the Talkeetna Island Arc Belt: In western Alaska the extension of the tectonic province of Southeastern Alaska includes the area between the northern edge of the Chugach geosyncline Cretaceous belt and the north edge of the Alaska Range. The igneous contacts are sharper and ore deposits are of shallower types. The Kennecott mine has been by far the most important producer in this area. From 1911 to 1938 it produced about 1.2 billion lbs of copper. The ore is a chalcocite, digenite

The now abandoned Old Fidalgo mine produced copper at Fidalgo Bay, 100 miles southwest of Kennecott.

and covellite replacement of dolomitized Chitistone limestone of Upper Triassic age. No pyrite or quartz have been introduced with the ore. The ore texture has been interpreted as indicating deposition from hydrothermal solution. The mineralogical simplicity suggests that the temperature was not high. The mine occurs on the flank of an anticline in the tectonic zone just north of the Chugach Mountains Cretaceous belt and south of the eastward extension of the Talkeetna island arc belt. Underlying the limestone is 5000 ft of Nikolai greenstone which may have been the source of the copper. In numerous places in the greenstone, small veins and masses of various copper minerals occur, usually associated with quartz, epidote or calcite gangue. It is possible that fluid circulation during the time when the Nikolai was altered to greenstone was responsible for the Kennecott deposit. A few deposits similar to Kennecott have been found in the area, but none of similar economic importance.

In the Prince William Sound area, the copper deposits are also associated with greenstone as at Kennecott. The principal sulfides of the deposits are pyrrhotite, pyrite, chalcopyrite and sphalerite. Quartz and epidote are commonly present. The ore deposits occur as lenses and disseminations in and along faults, in or near greenstone country rock. They are not associated with granite intrusives. The country rock is of Upper Cretaceous (?) age so that the ore must be of latest Cretaceous or Tertiary age. Copper production from 1900 until 1930 was 214 million lbs. Little copper has been produced since that time.

Gold-bearing quartz lodes occur in the slate-graywacke country rock of the Chugach Mountains along the north side of Prince William Sound. The deposits occur along faults but may be related to the granitic stocks in the area. The veins are mainly quartz, sometimes with calcite, and contain free gold, pyrite, galena, chalcopyrite, arsenopyrite and sphalerite. Stibnite is present in places. Pyrrhotite is present but subordinate to pyrite. These veins have the same mineralogy as the copper deposits associated with greenstone, but the proportions are different.

West of Prince William Sound, in the Girdwood district, small irregular gold veins with similar mineralogy to those described above occur near hydrothermally altered quartz diorite plugs. This gold province continues along the Kenai Peninsula and Kodiak Island.

Near the southwest end of Kenai Peninsula, two dunite bodies have intruded the slate-graywacke country rock. Chromite is associated with these bodies and has been mined during wartime and other periods of high prices.

The Talkeetna Mountains are in the same tectonic belt as the Wrangell Mountains and similarly, have a number of ore deposits clustered along their south side in the Willow Creek district (production $9.8 million). These are intermediate temperature deposits which have been emplaced along shear zones in a large body of quartz diorite. The gold quartz veins contain free gold, pyrite, arsenopyrite, sphalerite, chalcopyrite, tetrahedrite and galena. Ankerite is present along vein boundaries just as it is at the Alaska Juneau mine.

The southwest extension of this tectonic belt is remote and has been less intensively prospected than most other areas in Alaska. In the Lake Iliamna-Lake Clark area shows of copper have been found.

The Alaska Peninsula and the Aleutian Islands can be considered as a younger part of the Talkeetna island arc belt. The only active lode mining that has been done in this area was at the Apollo mine on Unga Island, where a 60-stamp mill was in operation around the turn of the century. The ore here is gold, pyrite, galena, sphalerite and native copper. The country rock is Mesozoic (?) andesite. A deposit containing sphalerite and pyrite occurs 250 miles further southwest on Sedanka Island.

North of Talkeetna Island Arc Belt, South of Alaska Range: On the north side of the Wrangell Mountains a northwest-trending belt of Permo-Tri-

The Kennecott mine as it appeared in 1929. It produced 938,000,000 lbs of copper before closing in 1938.

assic greenstone and limestone 10 to 20 miles wide separates the basic Cenozoic volcanics of the Wrangell Mountains from the Jura-Cretaceous graywacke-shale of the Nutzotin Mountains (Alaska Range geosyncline). Several areas of mineralization are known in this belt, the principal ones being the Chisana placer gold camp, the Nabesna mine and Orange Hill.

At the Nabesna mine (production $1.9 million), gold occurs in pyrite-calcite veins at the contact of diorite with Upper Triassic limestone. Other minerals associated with the ore are contact metamorphic silicates, magnetite, pyrrhotite, chalcopyrite, galena and sphalerite. Ten miles southeast of the Nabesna mine at Orange Hill, a quartz diorite body has intruded limestone and produced a large metamorphic aureole. Ore minerals deposited in the intrusive and the limestone are chalcopyrite, bornite, tetrohedrite, sphalerite, molybdenite, plus quartz and gypsum. This copper porphyry-type deposit is the only one of its kind known in Alaska, with the possible exception of the Golden Zone deposit 225 miles to the west in the same tectonic zone.

To the west, in the same belt between the Talkeetna island arc and the Alaska Range geosyncline, other ore districts occur. In the Chistochina district gold placers occur whose production in 1940 totalled $3 million. Further west in the Valdez Creek area the mineralization is reminiscent of the Juneau Gold Belt, with early low grade gold-quartz veins emplaced before or during metamorphism and later, richer, quartz veins showing hydrothermal alteration of the wall rock. The later veins carry native gold, pyrite, arsenopyrite, pyrrhotite and a little chalcopyrite. The mineralized area is in Triassic argillite just south of a granitic intrusive body. The area is strongly pyritized. A minor mineralized district with similar mineralogy occurs west of the Alaska Railroad on the West Fork of the Chulitna River. Here at the Golden Zone deposit a pyritized biotite-quartz diorite porphyry contains disseminated sulfides and gold in shear zones.

North of the Alaska Range, South of the Brooks Range: The principal metal produced in Interior Alaska has been gold, mainly mined from numerous placer deposits. The richness of these placers is one of the minor effects of the geomorphic history of the region during Tertiary time. During this period the topography was low and the stream gradients were gentle enough to retain any gold eroded from nearby ore deposits. Up warping and block uplifts were sufficiently active to allow slow erosion of many hundreds of feet of bedrock. This efficient concentrating mechanism was able to produce rich placers from low grade ores. This mechanism and the effectiveness of the placer gold prospectors are responsible for the considerable information available on the ore deposits in the Interior. It has been found that all or almost all of the ore deposits (mainly placers) in the Interior are partially associated with intrusive rocks, mainly granitic bodies less than three or four miles in diameter. These intrusives are of Mesozoic and Tertiary age. The Mesozoic intrusives are located in areas of schistose rock in the Yukon-Tanana region, the Ruby geanticline, the Brooks Range and on the Seward Peninsula. The Tertiary intrusives occur mainly in unmetamorphosed rocks of Mesozoic age on either side of the Ruby geanticline. The greater erosion may account for the fact that the richest placer camps have been near Mesozoic intrusives in areas of schist bedrock.

Fairbanks has been the richest and most accessible district. Its total production, mainly placer, from its discovery in 1902 to the present has been $197.9 million. Several small rich lode deposits have been mined. The veins are centered on three areas of intrusive rock in the district, and while some of them cut the intrusives, most are in the surrounding Precambrian (?) schist within six miles of the nearest intrusive. Some of the early quartz veins contain only gold and pyrite, but the later, richer veins contain gold associated with sulfides. The most common sulfides are arsenopyrite, galena, jamesonite, sphalerite and stibnite. Some lead-silver veins

with only a small gold content are present. Stibnite-quartz veins and veins containing only stibnite are present which have little gold. In addition to all these closely related gold-sulfide deposits, higher temperature scheelite deposits are present near the igneous contacts. The richest have formed as replacements in marble and calcareous schist near crosscutting quartz veins several hundred feet from igneous contacts. Cassiterite and wolframite have been found in the placers but not in place.

At Nome (production $104.9 million), the bedrock is schist interbedded with limestone. No granitic rocks crop out in the area. The veins have been either too small and erratic to mine or, if large, too low grade to mine. The minerals reported are free gold, pyrite, arsenopyrite, galena (which often contains silver), chalcopyrite, bornite, sphalerite, stibnite and scheelite. Cassiterite is not present. Premetamorphic quartz masses are present and some appear to be deformed veins and carry gold. Almost all of the ore deposition has been post-metamorphic and, in approximate order of deposition, includes lead and copper along shear zones at limestone-schist contacts, quartz veins and sulfide veins. Recent work by Hummel (1960) dates the older northerly-striking folds and metamorphism as Mesozoic and later ore-controlling faults and folds as Tertiary (?). This district resembles the Fairbanks district in many ways, and it has been suggested that granitic rocks are present at no great depth below the surface at Nome.

At Lost River, near the western tip of the Seward Peninsula, cassiterite and wolframite ore occur as a pneumatolytic replacement in and near a buried granite stock (Sainsbury, 1960). Contact metamorphic minerals are present as are the typical suite of minerals found at Nome and Fairbanks. Gold is present with cassiterite in nearby placers and, in fact, initial discovery of cassiterite was as an objectional constituent of the placers.

The Kantishna district, which lies just 40 miles north of Mt. McKinley on the edge of the Interior region, is mainly a small placer camp, but a number of veins are known and some have been mined. The mineral deposits are associated with quartz porphyry and diabase dikes along a band of limestone and chlorite schist in the Birch Creek schist bedrock. The three types of veins found include gold quartz, argentiferous galena, and stibnite, plus occurrences of scheelite and cassiterite. They are all characteristic of Fairbanks-type mineralization. It is very possible that this district, like Nome, may contain a buried intrusive.

Lost River and Fairbanks have similar deposits that differ only in detail. The intrusives have nearby high temperature tin-tungsten deposits and more remote lower temperature gold-sulfide deposits. The Nome and Kantishna districts probably fall in the same group. The Tertiary granitic stocks that extend in a long sporadic belt along the south side, and to some extent on the north flank of the Ruby geanticline, have a number of mineralized districts associated with them. Almost all of the mining has been placer so that even less is known about the geology than for the deposits associated with Mesozoic intrusives. The minerals that have been found are gold, cinnabar, stibnite, scheelite, cassiterite, chalcopyrite, galena and bismuthinite. Cinnabar is quite common and its occurrence has been used to differentiate Mesozoic from Tertiary granitic intrusives. Cinnabar deposits are seldom formed at a depth of over 1000 ft and their absence in districts associated with Mesozoic intrusives is most likely due to excessive erosion.

In the area paralleling the Tertiary intrusive belt are a number of cinnabar and cinnabar-stibnite deposits which are not associated with the granitic rocks in any obvious way. The largest of these deposits, the Red Devil mine, is located on an important wrench fault as are some of the others.

Brooks Range: On the south side of the Brooks Range at Ruby Creek, a large low temperature copper deposit has recently been discovered in dolomitic reef breccia of Middle or Upper Devonian age. The deposit contains marcasite, chalcopyrite, supergene (?) bornite and supergene chalcocite in masses and disseminations. No quartz is present and no granitic rocks occur in the vicinity. All of the rocks in the area are metamorphosed, and the ore, which is post-metamorphic, may have been deposited as the result of metamorphism of the basic rock underlying the dolomite. Little is known concerning the role of metamorphism in the history of the Brooks Range. The dolomite at Ruby Creek may be part of the Skajit limestone. In an area between Wild Lake and the John River 140 miles east of Ruby Creek, copper sulfides are common in breccia beneath the Skajit limestone (Brosgé, 1960). Whether the Ruby Creek deposit proves to be an isolated "elephant" or a part of a copper province remains to be seen.

This report is a provisional sketch of the geologic evolution of Alaska, based mainly on the many publications of the U.S. Geological Survey which cover individual areas. It owes much to Gabrielse and Wheeler's *Tectonic Framework of Southern Yukon and Northwestern British Columbia* and to Miller, Payne and Gryc's *Geology of Possible Petroleum Provinces in Alaska*. The widespread importance of the Gemuk eugeosyncline has been pointed out by Cady, Wallace, Hoare and Weber (1955). The suggestion that the geology of Prince William Sound-Alaska Range area has been largely controlled by the Talkeetna island arc system is my own. It is a useful synthesis for a report of this nature but needs further testing by workers in the area. Dr. Robert Forbes of the University of Alaska has kindly read over the manuscript and made many helpful suggestions.

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PROSPECTING AND POLITICS

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Although Alaska has been the site of the world's last great gold rushes, the birthplace of the world's largest copper mining company (Kennecott), and, at one time, the home of the world's lowest cost, underground gold mine (Alaska-Juneau), and it still has by far the largest undeveloped area of any state or group of states in the nation, it receives relatively little attention from prospectors. In 1958 and 1959, at the time of the admission of the Territory of Alaska as the Forty-Ninth State, much publicity was given to the belief that Alaska has "vast, untapped resources" but the theme seemed to impress real estate men more seriously than it did prospectors.

Prospecting is a sometimes simple, often technical, always surprising form of gambling that is absolutely essential to the national economy. But it is also a business, subject to careful evaluation as to cost and possible profit. Essentially, there is little difference in thought process among the prospector who weighs the possible value of a discovery in the hills against a well paid, comfortable job in the city; the investor who must decide between putting funds into a wildcat prospect or into mortgage notes; and the mining executive who chooses the locations where prospecting funds will be spent. Only a few of these have chosen to prospect in Alaska. Many more have been deterred from doing so by the widely held belief that most of Alaska is inaccessible and, as a consequence, only the rare, rich deposits can be mined.

Actually, much of Alaska has always been geographically accessible. The total coast line of the state is greater than the combined Atlantic and Pacific coast lines of the "Old Forty-Eight States"; 60% of the land area is within 400 miles of a year-round ocean port and 90% is within that distance if the seasonal ports on Bering Sea are included. The steamship lanes between the west coast and Japan approach the Alaskan coast. The Yukon-Tanana and Kuskokwim Rivers are navigable for long distances and with comparatively minor improvements, including a short canal between them, can be developed into one of the great inland waterways of North America.

The federally owned Alaska Railroad, in operation since 1923, has recently announced a plan to extend its trackage eastwardly along the northern flank of the Alaska Range. New primary and secondary roads are being constructed by the state with Federal funds at a more rapid rate than ever before.

WHY PROSPECT IN ALASKA

Although shipping costs from port-accessible locations are not burdensome, travel to and from the state is easy, and power is either now available or capable of development, construction costs are two to three times as high as in the western states and mine operating costs are from 25% to 35% higher. However, these high costs *must* be balanced by other considerations, of which high unit value is only one. More importantly, it is probable that within a few years the fact that an Alaskan mineral deposit is on U.S. soil will do much to outway the cost disadvantage of exploiting it.

S. G. Lasky, in a common sense discussion[1] of mineral supplies, has pointed out that increasing dependence on imports is inevitable in the history of any nation that industrializes. While one might think, or hope, that an increasing rate of industrialization throughout the world would promote free trade among the various nations who become more and more interdependent for imports of raw materials, there is little sign that such trade will be established. Nor is there any indication that the U.S. itself is ready to promote free trade in natural resources.

Placer prospecting near the Yukon River. Such work still accounts for a large portion of Alaskan exploration.

The fractured colonial systems of Africa have given way to a multiplicity of highly nationalistic, untrained governments who are not likely to resist the temptation to impose erratic, even irrational, controls on mineral exports as a means of obtaining loans, concessions and gratuities and, above all, to display their new power against their former masters.

In Latin America and Canada there is an understandable trend towards forced vertical integration of the metal industries. The growing copper fabricating industry in Chile is one illustration; the demand by some of the Canadian press and political leaders for increasing employment through additional processing of metals before export is a constant reminder. Heavy export duties, controls and quotas, now favored by some nations as means to expand the manufacture of goods based on domestic ores, are likely to be continued and to become more widely adopted. They will affect the cost and availability of metal to U.S. fabricators and thus tend to erase the competitive advantages of U.S. superiority in manufacturing and marketing. It is impossible to control a market for finished products if the raw material source or even a substantial portion of the source is controlled by an ambitious competitor.

Even though C. W. Merrill[1] has demonstrated that the real prices of mineral commodities have been declining and has predicted that advancements in technology will permit the decline to continue, there is evidence that the fields (i.e., the mines) to which technological improvements can be applied are being narrowed. The brilliant work that brought Nicaro and Moa Bay nickel mines into production in Cuba was all in vain. Speaking of his company's Moa Bay project, an official of Freeport Sulphur Co. in 1956 said, "It's more important to have a good supply than low prices." The observation is wise but events proved that that particular foreign supply was not "good".

A look around the world should encourage a little more searching for the "vast, untapped resources" of Alaska's 586,400 square miles. Whatever their value might be, these resources are politically accessible.

PROSPECTING METHODS

All methods of prospecting can be employed in Alaska, from airborne geophysics to tracing float or colors. There are even plenty of willow wands for their admirers. However, there are some features that differ from those to which most prospectors in the states are accustomed.

Geophysical surveys are affected in several ways. The prevalence of graphitic series in many of the metamorphic rocks gives the usual, predictable confusion, but it was somewhat surprising to find that the lesser intensity of electrical storms made it necessary to develop special AFMAG equipment. Permanently frozen ground through most of interior Alaska poses problems which have not been completely solved. Induced polarization, with adequate care given to contacts with frozen soil apparently works satisfactorily, but spontaneous polarization over frozen ground may give misleading results. Applicability of seismic work to shallow depths of frozen ground has not yet been shown.

Geochemical testing of soils appears to work well with residual soils and somewhat less well with stream sediments. It appears to be useless in transported soils, especially those of glacial origin, and has yet to be demonstrated in the frozen "muck" (silt, ice and vegetal matter) that covers many valleys and hillsides. Possibly, geochemical testing of the long-lived spruce and bunch-grass will have some value in such soils.

Geochemical testing of water may be particularly valuable in Alaska. Leo Mark Anthony, staff member of the University of Alaska, found that water samples taken during the winter by boring through the ice showed sharper anomalies, capable

of much better duplication, than water samples taken during the open season. It is probable that, during the winter, streams more readily reflect the metallic ion content of the bedrock sources of water and so could be used to prepare a reasonably reliable geochemical map.

The time-honored method of prospecting by tracing float or panning for heavy minerals works well, but a prospector newly arrived in the northern climate must carefully consider the effects of ancient glaciation in those parts of Alaska that have been glaciated as well as the importance of soil creep.

Ancient glaciation is sometimes difficult to recognize but it pays to do so. One of the important silver veins in Yukon Territory of Canada (which is similar to Alaska) was discovered by a prospector who followed float laterally along the fringe of a former ice flow. Although much of interior Alaska has not been glaciated, tremendous silt deposits formed during the glacial ages. These filled valleys, caused drainage reversals and formed new stream beds, all of which may have affected the train of float or colors.

The phenomenon of soil creep is caused by the progressive thawing of soil and ice-fractured bedrock within the zone of seasonal thawing. The wet, semi-plastic mass of thawed material moves over the slippery, frozen surface beneath, which, when exposed, repeats the process. In this manner a considerable depth of material that resembles weathered bedrock in situ can accumulate on a hillside; in extreme cases "rock glaciers" will partially choke a stream bed. Beyond or above the tree line, soil creep, assisted by snowdrifts, can form benches that are often mistaken for ancient water courses or accepted as evidence of differential resistance to rock weathering.

Soil creep is quite confusing to the little mineral fragments which set out in search for a prospector. For some reason, a mineralized outcrop (not a barren quartz vein) usually breaks up and feeds the creeping soil at a faster rate than the surrounding rock. This causes the outcrop to bend, to pinch and possibly to be covered by the mass of rock fragments that slowly advances from its up-hill side. The wise prospector is cheered when his float "goes down" and is elated when he finally loses it, as he then knows where to dig in earnest.

Another arctic and sub-arctic phenomenon closely related to soil creep is the widespread "boil hole", which is a slowly and intermittently moving rock fountain caused by recurrent cycles of saturation, freezing, expansion and thawing. By this process, underlying bedrock is often brought to the surface through a soil or gravel cover.

The newly arrived prospector will be dismayed at the lack of outcrops. The bays and fiords of the southeastern and southern coasts have fairly good exposures along their fringes and the mountains boldly display their rocky souls to helicopters and the more venturesome mountain goats, but the foothills and older mountain systems are largely covered with moss, bunch-grass and brush. Many of the streams in the interior run over muck and so do not even offer gravels as clues to bedrock. It is easy to see why the old time prospector had no stomach for lode prospecting and contented himself with "burning" a hole to bedrock in a nice-looking valley.

There is no easy way to get around the problem of cover. Geophysical and geochemical surveys, aerial photos and geological observations may narrow the target area but there remains the painstaking inspection of boil holes, rock and mud slides, creek banks and rare outcrops, and the tough job of getting holes down to search for float or material to pan. Lightweight power augers have been very successful in speeding up that phase of the work, as has been shown by the USBM.

Actually, there are only a few prospectors who go wild-catting. Most exploration men visit and revisit well known prospects, record observable geology and write new reports on old holes. One prospector who preferred digging to reporting turned a few 40-year old prospect holes into the best bet for a big league mine that has been seen in Alaska for many years. This prospect, located near the Kobuk River in northwestern Alaska, is Bear Creek Mining Co.'s Ruby Creek project.

An investigation of old prospects should not exclude the old placer mines. In some of these, bedrock is visible in open cuts, and nearly all of them display bedrock on the tailing piles. Oddly enough, placer miners frequently cross mineralized zones with hardly a look; this is particularly true of dredging.

A study of the old placer camps usually reveals the trends of bedrock mineralization which can be used as guides to undiscovered lodes and placers, if they exist. The large, rich Cripple Creek placer in the Fairbanks camp was not found until nearly 30 years after Felix Pedro had started the big gold rush to that area; during this past season a new, rich discovery is reported in the heart of the old Ophir camp. The well known platinum placer of the Goodnews Bay Mining Co. has been dredged since 1938, but it was not recognized as an important mine until a few years before that date, even though it was not far from an old gold producing district.

Unfortunately, studies of most outcrops and old mines and prospects can be done only during the short summer season. Nevertheless, much useful winter work can be done. Frozen ground permits the movement of heavy equipment and freight that often cannot be transported during the summer; frozen lakes are available for large cargo planes in places that can be reached only by float planes during the open season. Line cutting, claim staking and drilling can be done, sometimes more easily during the winter.

Airplanes, especially helicopters, are available at attractive winter contract rates, and this fact can be used to reduce the cost of airborne geophysical surveys. As has been noted, water testing is apparently more reliable during the winter.

The vast, untapped resources of Alaska will require a lot of tapping with all of the prospector's present tools and all that he can devise for the job. But the veil of cover and the bars of winter will yield to the necessity of obtaining new sources of mineral wealth.

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MINING ACTIVITY IN ALASKA

According to the latest published report from the Division of Mines and Minerals of Alaska's Department of Natural Resources, the following companies were among those active in the State during 1960.

EXPLORATION

Owner	Location and District	Type of Operation
American Metal Climax Vancouver, B.C.	Alaska general	Mineral investigation
American Smelting & Refining Co. Vancouver, B.C.	Alaska general	Mineral investigation
Columbia Iron Mining Co. Pittsburgh, Pa.	Southeast Alaska	Mineral investigation
Cordero Mining Co. Palo Alto, Calif.	White Mtn. McGrath	Mercury lode explorations
Fremont Mining Co. Forest Grove, Ore.	Southeast Alaska	Mineral investigation
Glacier Mining Co. Anchorage	Hayes River Anchorage	Molybdenite exploration
Humble Oil & Refining Co. Anchorage	Bristol Bay Dist.	Mineral investigation
Ideal Cement Co. Ft. Collins, Colo.	Ketchikan Dist.	Mineral investigation
Moneta Porcupine Mines Vancouver, B.C.	Southeast Alaska	Mineral investigation
Mt. Andrew Mining Co. Vancouver, B.C.	Kasaan Peninsula Ketchikan	Iron and copper exploration
Newmont Mining Corp. of Canada, Ltd. Vancouver, B.C.	Alaska general	Mineral investigation
Permanente Cement Co. Oakland, Calif.	Kings River Palmer	Limestone exploration
Phelps Dodge Corp. Douglas, Ariz.	Alaska general	Mineral investigation
Prince of Wales Mining Co. Vancouver, B.C.	Southeast Alaska	Mineral investigation
Sunshine Mining Co. Spokane, Wash.	Kagati Lake Bethel	Mercury lode exploration
Transworld Resources Hesperia, Calif.	Yakataga Beach	Placer exploration

* Mining companies reported to be investigating Alaska during the past summer include the following: Newmont Mining Co., Fremont Mining Co., American Metals Climax, Phelps Dodge, Hanna Mining Co., Chattuck Denn, Utah Construction, Kennecott Copper Corp., Texas Gulf Sulphur, Moneta Porcupine, Sunshine Mining, Cordero Mining, Asbestos Corp. and various Japanese concerns.

MINING AND DEVELOPMENT

Owner	Location and District	Type of Operation
Alaska Mines & Minerals Anchorage	Red Devil Kuskokwim	Mercury production
Alder Creek Mining Co. Fairbanks	Fairbanks Creek Fairbanks	Nonfloat**
Alluvial Golds, Inc. Seattle, Wash.	Woodchopper Creek Fairbanks	Gold—dredge
Bear Creek Mining Co. Spokane, Wash.	Ruby Creek Noatak-Kobuk	Copper lode development
Goodnews Bay Mining Co. Seattle, Wash.	Salmon River Bethel	Platinum—dredge and nonfloat
Inmachuck Mining Co. Nome	Inmachuck River Fairhaven	Gold—dredge
Lee Bros. Dredging Co. Nome	Solomon River Cape Nome	Gold—dredge
New York-Alaska Gold Dredging Corp. Seattle, Wash.	Tuluksak River, California and Rock Creeks Bethel	Gold—dredge
Otter Dredging Co. Flat	Otter Creek Mt. McKinley	Gold—dredge
Strandberg Mines, Inc. Anchorage	Hot Springs, Ft. Gibbon, Innoko	Nonfloat**
United States Smelting Refining & Mining Co. Fairbanks	Fairbanks, Hogatza River, Cape Nome, Chicken	Gold—dredge
Wolf Creek Mining Co. Fairbanks	Fish Creek Fairbanks	Nonfloat**

** *Nonfloat* indicates mechanical placer gold operation using draglines and/or bulldozers to transport gravel to nonfloating washing plant, bedrock sluiceboxes or elevated sluices.

COAL

Arctic Coal Inc. Fairbanks	Lignite Creek Nenana Field	Strip
Cripple Creek Coal Co. Fairbanks	Cripple Creek Nenana Field	Strip
Evan Jones Coal Co. Anchorage	Jonesville Matanuska Field	Strip
Meade River Coal Co. Barrow	Meade River Pt. Barrow Field	Underground
Mrak Coal Co. Sutton	Eska Metanuska Field	Strip
Usibelli Coal Mines, Inc. Fairbanks	Healy Creek Nenana Field	Strip an underground

EVAN JONES COAL OPERATION

by COLE E. McFARLAND

Assistant Mine Superintendent
Evans Jones Coal Co.
Palmer, Alaska

Organized in 1920 by a group of Anchorage businessmen, the company continues to bear the name of the original prospector and first president, the late Evan Jones. President Oscar Anderson managed the company from the mid-1920's until 1944 when veteran Alaskan mining and businessman, Harry J. Hill acquired a partnership in the organization. Following World War II the company, under the aggressive management of Mr. Hill, rapidly expanded production output to meet the accelerated demand for coal needed to supply heat and power for expanding military defense bases. In 1956 American Exploration and Mining Co. acquired a substantial interest in Evan Jones, and in 1959 the remaining block of Hill-Anderson stock was purchased by the Western Reneline Corp. of San Francisco. In October 1959, Mr. Alan G. Horton, formerly in charge of American Exploration and Mining's southwest exploration section, was elected President and General Manager of the Evans Jones Coal Co.

The company holds a 2560-acre lease in the Wishbone Hill District, 60 rail miles northeast of Anchorage, Alaska. Lying in the center of the Matanuska Coal Field, the district contains the only known workable deposits of bituminous coal within the Alaska "railbelt" area. In over 40 years of continuous production the company has shipped approximately 4,500,000 tons of clean coal. Served by a 15-mile spur of the Alaska Railroad, the property is three miles from the paved highway leading from Anchorage to Fairbanks.

Evan Jones property (arrow) lies in Matanuska Coal Field.

MARKETS

Over 90% of current clean coal production is tagged for steam plant delivery at two large defense facilities, Fort Richardson and Elmendorf Air Force Base, located near Anchorage. Current specifications include 13.5% ash and 12,500 Btu, dry

basis, and 7.9% as received moisture. Bid price is $9.90 per ton f.o.b. mine and $2.54 per ton is charged for the 60-mile rail haul. It is interesting to note that when heat and power requirements are in balance, the military at Fort Richardson and Elmendorf can generate power for 6.5 mills per kw, compared to 10 mills per kw for the small Eklutna Hydroelectric Plant which is located 25 miles northeast of Anchorage.

The 15,000-kw Knik Arm Steam Plant in Anchorage burns about 30,000 tons annually. The present two-year contract to this plant is held by nearby competitor, the Mrak Coal Co.

The discovery of natural gas on the Kenai Peninsula and the subsequent completion of a pipeline to Anchorage has posed a serious threat to the local coal industry. Paradoxically, the fossil fuel industries are united in their stand for thermal generation as opposed to small high-cost hydroelectric projects. In the projected rapid expansion of area power generation requirements, there is room for growth in the entire mineral fuel industry and the Evan Jones Coal Co. looks forward to participation in this growth.

GEOLOGY

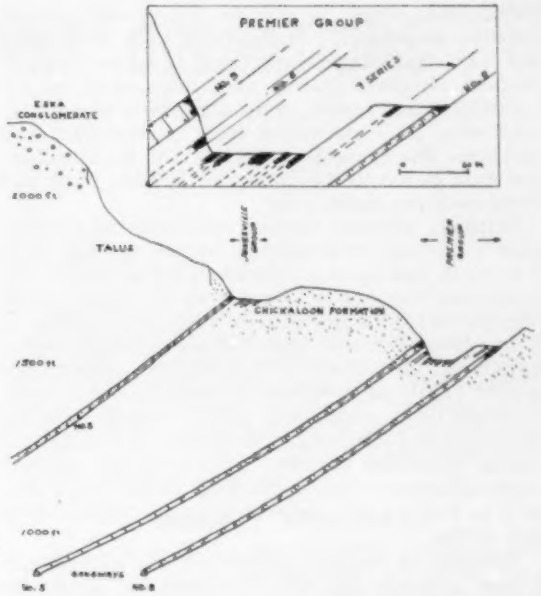
Quoting F. F. Barnes and Thomas G. Payne in U.S. Geological Survey *Bulletin 1016*: *

> "The coal bearing rocks of the district are Tertiary in age and include all gradations from coarse sandstone and conglomerate to claystone; they are mostly concealed by a mantle of Quaternary deposits or by a capping of younger Tertiary conglomerate. . . . The dominant structural feature of the district is the Wishbone Hill syncline, a canoe shaped fold that extends the full length of the district and is out into segments by several major transverse faults. Mining has been restricted largely to the ends and to the moderately dipping north limb of the fold, as the outcrop of the south limb of the coal bearing formation is deeply buried beneath slide rock and glacial deposits. . . . The coal bearing Chickaloon formation is at least 3000 feet thick, but the coal beds are confined largely to the upper 1400 feet, where they occur mainly in four groups of three or more beds, which have been named in descending order, the Jonesville, Premier, Eska and Burniny Bed coal groups. Principal production to date has been from the Premier group in both the eastern and western parts of the district, and from the Eska group in the eastern part."

The coal is classified as high volatile *B* bituminous rank with poor to non-coking qualities. The Premier series, presently being mined, includes seven seams, two of which are separated by substantial partings resulting in nine mineable beds which vary from 1 to 17 ft in thickness. For washability considerations, the seams are classified as clean, intermediate and dirty with roughly one-third of total coal falling into each category. The beds dip from 30° to 50° south, approximately normal to the hill slope. Estimated reserves exceed 40 million tons, of which approximately 10 million are located on the partially developed north limb. Strippable reserves are estimated at two million tons with about 500,000 tons developed in current pits.

UNDERGROUND MINING

From 1920 until first stripping began in 1953, all production was from an underground mine employing a standard room-and-pillar method. About 1952, in the No. 5 seam workings, shaker conveyors were



Pit cross-section looking west. Both the coal seams and the parting rock narrow in width to the west.

employed for cross-pitch movement of broken coal to central loading chutes. Following a later switch to chain conveyors the cross pitch method was used to considerable advantage. It is noteworthy that from the early 1950's considerable experimentation with mechanical equipment, as well as modification of mining methods in use, was accomplished in an attempt to offset the rising cost of labor. A Joy J-4CM continuous miner, boring (donut) machines, cutting machines and augers were all tried on the 35° pitch with only limited success. Improved results from the new strip operation and rising underground costs were important factors affecting the decision to close the underground mine in May 1959. However, present management of the company is closely following current research aimed at developing improved methods for mining pitching seams underground.

OPEN PIT OPERATIONS

Currently all raw coal is mined in the open pit and, under present contract commitments, production ranges from 900 to 1000 tpd with two shifts operating. Selective mining of the narrow pitching seams with minimum footwall dilution, a mile-long active pit area, and extreme winter conditions are problems which are further complicated as the seams immediately underlying the 250-ft highwall can only be worked from late October until mid-April when freezing conditions prevail. Although a yearly average mean temperature of 35° with minus 15° to 20° lows is not exceptionally severe, a combination of low temperatures and a 40 to 50 mph "Matanuska" wind howling off nearby glaciers gives the pit every appearance of an arctic testing laboratory. Snowfall is not exceptional, averaging less than five ft, but drifting is often troublesome. During the short winter days (averaging 5½ hours of sunlight), portable light towers provide additional light in the pit.

Stripping: Normally only a light mantle of unconsolidated overburden is encountered on the steep

hillside slopes and, except for draws and natural benches, removal of this material with a dragline and two bulldozers constitutes a minor part of over-all pit development costs. Position of the pit highwall is set according to a predetermined limiting strip ratio calculated from stratigraphic and cost data. The equipment is worked in the combination best suited to the particular hillside slope and distance to the dump area.

Drilling: Material ranging from coal to medium hard sandstone, rock parting widths varying from 2 to 20 ft, and an exceptionally long pit area were conditions that had to be met in choosing a drill best suited for the pit. Several years ago, contractor Minor Roop, working with various technical representatives, developed a drilling rig which has proved highly satisfactory. A Gardner-Denver unit mounted on a model 2FD Euclid chassis, this rig includes a 900-cfm rotary compressor operating two 4½-in. reversible hammer drills mounted on 14-ft masts attached to hydraulic gibs. Holes are drilled on 4 to 6-ft centers, depending on parting material and width.

Blasting: Following a suggestion that a change in primer strength for AN-FO detonation would be beneficial, company personnel researched available information and corresponded with several explosive manufacturers, but information pertaining to optimum primer strength and recommended primer-agent weight ratio for short column, small diam loading was not available. This lack of information coupled with high powder costs (see Table I) has dictated limited experimentation. Currently, about 10 lbs of AN-FO mixture is bottom-detonated with one 2x12-in. stick of RC 50% Extra. Additional primers of varying size and strength are on order. Explosives are distributed with a 1½-ton Ford truck, equipped with a detonating device, galvanometer, siren and rotating red beacon. The holes are connected with electric millisecond delay caps and the circuit is tested. The pit is then cleared and the shot fired.

Table I. Bed Variation of Ash-Yield Characteristics

Bed	Float 1.40		1.40 to 1.60		Sink 1.60	
	Yield %	Ash %	Yield %	Ash %	Yield %	Ash %
5	37.0	8.6	23.4	28.3	39.6	64.0
6	50.0	5.7	13.1	27.8	36.8	70.2
7 Upper	62.9	4.9	16.6	27.9	20.5	70.7
7 Lower	61.7	4.8	13.0	28.9	25.3	57.9
7A	51.3	5.3	12.5	28.4	36.2	72.3
7B Upper	79.4	4.1	8.1	27.4	12.5	60.2
7B Lower	66.7	4.3	9.7	28.3	23.6	63.9
7C	59.4	3.9	5.3	27.0	35.3	72.2

Table II. Some Miscellaneous Costs

Item	Unit	Cost*
Diesel Oil	Gallon	$0.261
Gasoline	Gallon	$0.367
Ammonium Nitrate (Fertilizer Grade)	80 lb bag	$5.48
40% Extra—1½ x 12-in. cartridge	Case	$13.22
50% R. C. Extra—2 x 12-in. cartridge	Case	$14.85
Magnetite	100 lb bag	$6.17
Labor—(1) Truck Driver	Hour	$3.825
Labor—(2) Shovel Operator	Hour	$4.625

* Cost of materials delivered to mine site.

* F. F. Barnes and T. G. Payne: The Wishbone Hill District, Matanuska Coal Field, Alaska. U.S. Geological Survey *Bulletin 1016*, 1956.

Loading: Considered impractical if not impossible in earlier days, loading out 14-in. dipping coal seams with a 2½-yd shovel, while holding footwall dilution to a minimum, is now standard procedure. Two 2½-yd shovels and a short boom dragline, all Northwest model 80-D's, handle pit loading requirements. One of the shovels is an older model used primarily for standby and to reduce shovel travel time in the long pit. The dragline is required to load both rock and coal when the pit floor becomes too narrow for shovel operation, especially in the area immediately below the highwall.

Haulage: Powered by 275-hp Cummins diesels, five tandem-axle Kenworth rear dumps mounted with 17 yard boxes handle the 5¾-mile roundtrip coal haul to the grizzly. Averaging about 5.5% with a maximum grade of 12%, the wide, well drained haulage road offers a minimum amount of trouble during the spring "break-up" period. Normal winter haulage problems are encountered.

PREPARATION

Flexibility and *control* have become the key words in the modern 100-tph preparation plant. Washing several seams and seam-blends with extreme variability in washability characteristics while striving to maintain less than 1% to 2% variation in product ash requires close cooperation between mining and plant personnel. Where possible, selective mining, limited stockpiling and process blending lend constancy to feed conditions which in turn minimize required circuit adjustments in the plant.

The raw coal passes an 8 x 12-in. rail grizzly enroute to an 800-ton raw coal bin which, with a small amount of outside storage adjacent to the underground tipple, will allow the plant to operate for a full eight-hour shift. The plus 3-in. is crushed in a Gruendler 3XB hammer mill and the 3-in. x 0 is conveyed to a 4 x 12-ft double-deck Allis-Chalmers "Lo head" vibrating screen where the minus ¼-in. is bypassed through a mechanical distributor to a bank of three No. 7 Diester tables. The table product is gravity-fed to a 48-in. spiral classifier where the underflow feeds directly onto a 3 x 16-ft Allis-Chalmers dewatering screen fitted with ½-mm wedgewire screen. Classifier overflow is gravity fed to the sump tank below the dewatering screen and mixed with the minus ½-mm screenings. The resulting slurry is pumped to a bank of three No. 9 two-stage Kreb cyclones operating under 20 psi. The cyclone underflow drops onto a plate which retards flow velocity and permits the slurry to fan gently onto the fine coal bed, which then serves as a filter medium as the mixture traverses the length of the dewatering screen. The coarse ¼ x 3-in. coal is cleaned in a Wemco 7-ft HM cone with a standard magnetite recovery circuit which has been adjusted to permit gravity variation from 1.50 to 1.80 on short notice. A densimeter provides a constant gravity reading augmented by standard flask weighings every 15 min. The coarse and fine coal combination is mixed at the lip of the 3 x 16-ft dewatering screen and conveyed to sizing and storage facilities. Both the combined 3-in. x 0 steam coal and the minus ¼-in. x 0 table coal are sampled at 15 min intervals. Ash analyses are recorded with table settings and cone gravity for various feed conditions providing a basis for future circuit adjustments. Reject is transported by truck from a 500-ton rock hopper to the dump area, 2000 ft away.

USIBELLI COAL STRIPPING OPERATIONS

by WILLIAM I. WAUGAMAN

General Manager
Usibelli Coal Co.
Fairbanks

Usibelli operations (arrow) are in the Alaska Range.

The Usibelli Coal Corp., founded in 1942 by Emil Usibelli, is Alaska's largest coal producer. Located 110 miles south of Fairbanks, the Usibelli properties are part of the Nenana coal field, an area 20 miles wide by 130 miles long in the northern foothills of the Alaska Range.

Usibelli operational facilities are contained at two locations, both on the Healy River. The lower camp, Suntrana, is at the end of a rail spur which joins the Alaska Railroad main line at the village of Healy, 4½ miles downstream. This rail spur is the only surface transportation available to the valley. Suntrana is the site of an operating underground mine, a power generating plant, an underground maintenance shop, and a tipple which processes coal from both underground and open pit operations.

The upper camp at Usibelli, Alaska, is located 2½ miles upstream from the railhead at Suntrana. This camp houses the crews that operate an open pit mine and cleaning plant. Also located here are the maintenance shops, warehouses, vehicle storage, main power plant and the coal cleaning plant. There is an underground mine at this camp but it is not in operation at the present time.

The two camps are connected by a 40-ft wide gravel road over which coal from the open pit and washing plant at Usibelli is hauled to the tipple at Suntrana. In fact, the valley has only eight miles of road passable for passenger vehicles but has four airfields.

MARKETS

Usibelli Coal Corp. will produce more than 500,000 tons of sub-bituminous coal in 1961, most of which will be shipped to markets in the Fairbanks area. The major market for coal from the Nenana field is the northern defense complex containing power and heat plants for three large military installations, one of which is the new "Clear" site. This military market normally consumes about 70% of the coal production. The remaining 30% goes to a power-heat plant operated by the Fairbanks Municipal Utilities, a power plant owned by the Golden Valley Electrical Association, and a sizeable domestic coal market.

GEOLOGY AT USIBELLI

Coal mined in the Nenana field ranges in grade from lignite to sub-bituminous *A*. The coal presently being mined on the Usibelli properties is sub-bituminous *A* and *B* containing on an average of 21% moisture, 7% ash and 8600 Btu as received.

There are five seams of coal that are economically mineable on the Usibelli leasehold. Although they vary from 14 to 50 ft in thickness, only two contain sufficient impurities to require processing through a cleaning plant.

The geology of the pit area naturally dictates the location of the mining operations and the mining methods employed. The leasehold is located in such a manner that it straddles the Healy River, and the coal seams strike diagonally across the property from the northwest corner to the southeast corner. The seams on the north side of Healy River dip about 28° north into the mountain, and the coal on the south bank dips from 20° to 35° with the slope of the mountain. In view of this, the underground mines are located on the north bank of the Healy and the open pit mine on the south side.

Overburden on the uplifted coal seams in the open pit area consists of two strata of material. The top stratum is a mantle of 10 to 30 ft of frozen humus, peat, decomposed schist and schist boulders. Underlying the mantle is a zone of permafrost composed of frozen Tertiary gravel varying in thickness from 6 to 40 ft. The coal seams, individually separated by layers of weakly consolidated, frozen sandstone banded with clay lie between the gravel layer and a Precambrian schist.

HYDRAULIC STRIPPING

Due to permafrost and climate considerations, all overburden must be removed during the four summer months. Thus enough coal must be uncovered during this time to allow uninterrupted mining during the winter when further stripping is impractical. Although the amount of stripping will vary with market conditions, up to 450,000 tons of coal have been stripped in a season.

Stripping is accomplished in four steps: 1) dislodging of vegetation and sod; 2) removing the mantle of frozen muck and gravel layers from the outcrop tips of the coal seams; 3) drilling and shooting the sandstone; 4) hydraulicking.

The vegetation that covers the area does not present much of a problem, but the removal of the

The Suntrana mine is the latest acquisition of the Usibelli Coal Corp. Portal to underground mine is at top center. Tipple is shown in upper center above houses.

Open pit operations are located 2½ miles from Suntrana. Shown are the warehouses, warm storage, washing plant (far right), quarters, and pit area (upper left).

mantle of frozen muck, rocks and gravel that cover the ends of the dipping sandstone and coal seams is another story. In a stripping procedure which is rather unique to the coal industry, hydraulic nozzles and bulldozers work together to remove the permafrost material thawed by the sun each day. Unless this thawed material is regularly removed, it will act as an insulator and impede further thawing action.

After the sod and gravel are removed, the sandstone overlying the coal seams is drilled with 9-in., 60-ft deep holes on 15-ft centers. Due to the fine texture of the sandstone, an auger-type vertical McCarthy drill is used for the drilling operation. The blasting agent used for breaking this overburden is ammonium nitrate prills and diesel fuel primed with 5-in., 25 lb sticks of 40% dynamite. Powder consumption is 2½ to 3 lb per cu yd.

Blasting permits aerating of the sandstone for better thawing, and produces material of such size that can be washed away to a drain by hydraulic nozzles. In this process hydraulic water thaws the sandstone pieces, reducing the material to a fine sand which can be sent through the drain to the Healy River. The river, in turn, carries the material out of the valley and into the glacial-fed rivers which drain the northern part of the state.

Although five thick seams occur on Usibelli property, only four are now being mined in the open pit. The lowest bed, known as "G" bed, is 14 ft thick and contains impurities requiring washing. This bed is directly overlain by No. 1 bed which is 50 ft thick and can be marketed without being washed. No. 2 bed, separated from No. 1 by 120 ft of loosely consolidated sandstone is 28 ft thick and requires washing. No. 3 bed is 18 ft thick and is separated from No. 2 bed by 150 ft of sandstone. The run-of-mine coal from this seam is clean enough to be marketed directly.

The coal is blasted by ammonium nitrate loaded into 6-in. diam horizontal holes. The coal is loaded into trucks by Model 955 P & H shovels equipped with 4½-cu yd buckets. The 2½-mile haul to the tipple at Suntrana is performed by six 600-hp Mack trucks of 40-ton capacity and four Model 234 International trucks of 18-ton capacity.

The washing plant at Usibelli operates only during the summer months. At the low temperatures prevailing in the interior of the state, it is impractical to operate the plant from October through April; freezing of wet coal in the cars would make unloading very difficult. As such, pit operations are planned to mine "G" bed and No. 2 bed during the summer, and No. 1 and No. 3 beds in the winter.

PROBLEMS OF MINE LOCATION

There are, of course, the normal problems which arise on any mining operation in the north country. These problems usually fall into three categories: distance, isolation and weather. The distance from suppliers dictates large inventories of parts and supplies. These inventories are usually far in excess of $200,000, and, in spite of these stocks, considerable air lifting of parts is required. The isolation makes it difficult to hire and keep capable skilled personnel and the extreme winter temperatures result in low efficiency.

Low temperature lubricants and warm storage for equipment tend to reduce winter operational problems, but when temperatures stay at −30° or −40° for extended periods, problems appear to multiply. The question, "How low can the temperature drop before open pit mining operations stop," is often asked. This question cannot be answered by the Usibelli management as the open pit mine has never been shut down due to temperature, despite temperatures of −54° on two occasions.

During the summer months the threat of floods is ever present. Due to the prevalence of permafrost preventing normal percolation of rainfall into the soil, the water run-off is very rapid. The Healy River, although quite small, laces over a floodplain that averages about 200 yd in width. Despite this expansive floodplain, and although the annual precipitation is less than 14 in., the river reaches flood stage every summer. When this occurs much natural erosion takes place and the river scours everything in its path. This usually includes bridges, bridge approaches, parts of the road, railroad fills and part of the airfield.

It has been said many times that Mother Nature gives up her natural resources very reluctantly. The Usibelli management is convinced that coal is no exception.

PRINCIPAL ALASKAN DREDGING OPERATIONS

Placer mining has been an important segment of the mineral economy in Alaska, accounting for about $6 million of the total annual value of the $21 million produced from minerals in 1960. However, in recent years placer mining has been suffering from the squeeze of rising costs of operation and the fixed price of gold. On the other hand, platinum from placer gravels at Goodnews Bay has been relatively stable since 1935. Most gold production comes from dredges operated by two big companies while the remainder is from sporadic mining by small groups or individuals using hydraulic monitors, draglines, and small dredges.

The effect of climate is an important factor in these dredging operations. In areas to the north, such as the vicinity of Fairbanks and Nome, permafrost and frozen gravels must be thawed; further south in the Kilbuck Mountain region, little permafrost is encountered but the ice must be cut from the dredging ponds in the spring and some frozen overburden blasted down. The dredging season lasts from 200 to 250 days during which around-the-clock operation is followed. Advanced planning of the season's operations is aided by reference to long-range weather forecasts.

United States Smelting Refining and Mining Co. is the largest operator of dredges in the state. In 1948, when the U.S. Smelting issue was published in *Mining & Metallurgy*, eight dredges were operated at Fairbanks, and four at Nome. This year the company operated four at Fairbanks, one at Chicken Creek in the Fortymile district and one at Hogatza River, about 250 miles northwest of Fairbanks. Two dredges were working at Nome. USSR&M recently announced that rising costs are causing a shutdown of all dredges in the Fairbanks area by the end of 1963, and in Nome by possibly early 1962.

USSR&M FAIRBANKS OPERATIONS

Before muck overburden can be striped it must be thawed. This overburden varies in thickness from a few feet to 150 ft in depth. Thawing is accomplished by introducing water at atmospheric temperatures. Muck thaws at the rate of about 1 vertical in. in 2½ hours. Water is normally introduced at eight hour intervals yielding a vertical advance of 9 in. daily. Thawed muck is washed away by hydraulic monitors which are only operated for short periods once or twice a day. This type of operation requires a large amount of equipment. For example, to strip an area of 30 to 40 acres ahead of one dredge, 36 to 48 monitors are employed. The washed muck is transported as a slurry to the nearest natural drainage.

Sites of major dredging activity: 1) Fairbanks; 2) Nome; 3) Nyac; 4) Goodnews Bay; 5) Hogatza River; 6) Chicken.

At the No. 10 dredge, operated by U.S. Smelting at Ester, about 10 miles from Fairbanks, the top 10 to 50 ft of barren gravel are removed by a Bucyrus-Monighan walking dragline with a 12-cu yd bucket on a 165-ft boom. The gravel is removed from the dredging area by a system of movable and telescopic 36-in. belt conveyors. Over 11,500 cu yd can be moved in a 24-hour period.

The gravels are thawed by driving ¾-in. pipe on 16-ft centers of an equilateral triangle pattern and piping water down at normal temperature. The water thaws the ground as it percolates back to the surface. When the section to be thawed is over 45-ft thick it is necessary to churn drill holes to bedrock on 32-ft centers. This work is performed in the winter time and the gravel is not thawed until water becomes available in the spring. It takes from 1½ to 2½ days per foot of depth for thawing. The frozen ground is at a temperature of about 30°F.

To determine if the ground is thawed in the thicker sections, it is necessary to place an extra pipe in the center of triangles at every twelfth thawing point. After thawing begins, temperatures are taken every 10 ft from bedrock with a resistance thermometer. Readings are obtained from a Leeds & Northrup Wheatstone bridge. Ground is considered thawed when the temperature reads 32.5°F. On shallower sections an experienced man can tell about the degree of thaw by driving a bar down into the gravel.

Water for thawing is recirculated from a pond at the lower end of thawing area by means of 6000-gpm double-suction, centrifugal pumps direct connected to 200-hp motors. About 1200 ¾-in. thaw points may be operated from one pump.

Each spring, before dredging can commence, ice must be cut from the ponds. Steam from the dredge boilers is used for cutting at a rate of about 70 sq ft per cutter hour. During the winter, about 2 to 6 ft of frost accumulates at the surface of previously water-thawed gravel which is steam-thawed ahead of dredging. This system, although carefully planned, is not 100% effective but it does prevent any big sections of unthawed gravel from slumping into the pond and blocking dredging.

Dredges are electric-drive, stacker type manufactured by Bethlehem and Yuba. Hulls are welded or riveted and compartmented pontoons. Specifications of one of the dredges are as follows: it has 10-cu ft buckets which dig at 20 buckets per min yielding 9000 cu yd per day. Digging depth is 60 ft below water line and 15-ft above. The steel hull is 167 ft long, 75 ft wide, and 12 ft draft, displacing 3170 tons. The connected load is 1612 kw.

Gravel from the buckets is hopper fed to a trommel screen perforated from ⅜th round to ⅞th slots at the end to catch occasional nuggets. Oversize goes over the stacker and undersize to the tables. The gravel is washed over the entire length of trommel screen. Thirty-inch wide tables are sloped at 1¼ in. per ft. Feed rate is about 5 cu yd per hr and 250 to 300 gpm of water. Gold is collected in mercury traps at the top and cocoa mats with expanded metal at the lower part. The traps are amalgamated every 24 hours and the mats taken up every 48 hrs. On the No. 10 dredge, single-cell 42-in. Pan American jigs are used ahead of table sluices and are credited with the recovery of 96% of the dredge production.

In some locations provision has had to be made for clay. Where this has been necessary, round-bottom buckets are used, they are sprayed at the hopper dump, and screen discharge is diverted through two stages of log washers to break up the clay balls.

Retorting, melting, sampling, and assaying are performed at the Farbanks laboratory.

USSR&M NOME OPERATIONS

In this area on the coast of the Seward Peninsula, ancient beach sands found below the tundra are being worked by two 9-cu yd Yuba dredges. Three main beach lines are situated from a few feet above sea level to 80 ft above sea level.

Water thawing for stripping and dredging may take from 70 days to two full thawing seasons to accomplish. Once gravel has been thawed it will remain unfrozen at depth indefinitely. However, the top few feet will freeze again over the winter.

Water for thawing, stripping, and dredging must be provided at considerable effort and expense at both Fairbanks and Nome. Water is ditched or pumped to working locations. At Fairbanks the principal ditch system is the 90-mile long Davidson ditch. It has its intake on the Chatanika River and has 15 inverted siphons totaling about six miles in length for crossing tributary rivers. The ditch has a capacity of 125 cfs. The Chena pumping plant supplying the No. 10 dredge has ten 14-in. double-suction centrifugal pumps rated at 6000 gpm against 220 ft head and direct-connected to 400 hp motors. Water is delivered through a 3-mile ditch.

At Nome there is a 110-mile system of ditches and laterals and sixteen 14-in. double-suction electrically-driven centrifugal pumps. When four dredges were formerly operated, this system would deliver 17 billion gallons of water during the thawing season.

A large number of the company employees are Eskimos.

GOODNEWS BAY

The reverse of the trend of gold mining in Alaska, the Goodnews Bay Mining Co. platinum placer mining operations have grown since its founding in 1935. The placer workings are on the Salmon river between the coast and the Kilbuck mountain range, with headquarters at Platinum. The company accounts for about 90% of the platinum produced in the U.S.

In this coastal area, there is not much permafrost and the few feet of frozen ground near the surface are blasted for stripping. The occasional lenses of permafrost which are met do not interrupt dredging. The company has one Yuba electric dredge with 8-cu ft buckets. Stripping is handled by bull-dozers, two Bucyrus-Erie draglines, and hydraulic giants. Another 6-cu yd dragline is used for mining in areas inaccessible to dredge as well as for stripping. The dredge handles more than one million cu yd per 200-day season; the dragline, about 600,000 cu yds; and stripping amounts to about another 200,000 yds.

Stripping operations are relatively light. However ice must be cut from the ponds in the spring. The gravel section which is dredged varies from 15 to 60 ft thick. Dredged gravel contains considerable platinum-bearing clay material. Gravel passes through a scrubber section and trommel. Oversize may be directed to the stacker or to a Jeffrey hammer mill. Hammer-mill discharge is returned to the trommel. Trommel undersize, passing through holes ranging in size from 5/16 to 5/8 in. is worked on tables where most platinum is recovered. A clean-up jig section follows tabling.

Dredge concentrates are further treated on shore by tabling, magnetic separation, and elutriation. Final concentrate assays 90% platinum and gold.

NYAC GOLD PLACER

North of Platinum, between the Kuskokwim River and the Kilbuck Mountains, are the gold placer diggings of New York Alaska Gold Dredging Corp., with headquarters at Nyac. Nyac is 65 air miles from Bethel, a port located on the Kuskokwim River.

Under normal conditions, the company has three dredges operating in the area. However, due to the damage to their hydroelectric power plant by fire, production is now limited to only two dredges. One operates 24 hr per day, the other works 10 hr. daily.

The power plant has been a key factor in economic operation. Instead of the 4¢ per kw-hr paid for power at Platinum, the hydroelectric plant yields power at 1¢ per kw-hr. Water is ditched from the Tuluksak River and piped under pressure of a 70 ft-head to the turbines. The generators develop 900 kw at about 41,000 volts. Standby power is available with diesels for use during water shortages before the thaw and in case of freeze-ups.

Certainly a great deal of ingenuity and stamina is required to mine under the rigorous conditions of Alaska. However, a great number of difficulties are overcome by planning activities for several seasons ahead.

THE RED DEVIL MERCURY MINE

by ROBERT F. LYMAN

General Manager
Red Devil Mine

The Red Devil mine is one of the major American mercury producers and the only continuously operated metalliferous underground mine in Alaska during the past six years. Discovered by two prospectors in 1933, these men operated the mine on a retort scale until 1942, when they leased it to New Idria-Alaska Quicksilver Mining Co. This company and its successor, the Kuskokwim Mining Co., operated a 30-ton capacity rotary furnace plant on the property until the fall of 1945. In 1952 the property was leased to the DeCoursey Mountain Mining Co. which operated the mine until October 1954 when a fire wiped out everything except a few living quarters. Total production to this date was about 4000 flasks.

The company obtained new financing to rebuild through the Canadian firm of Brewis and White, Ltd., which organized DeCoursey-Brewis Minerals, Ltd. DeCoursey Mountain Mining continued to operate as a wholly-owned subsidiary of DeCoursey-Brewis Mineral, but the operating company's name was changed to Alaska Mines & Minerals, Inc., in 1959. Production by this company since the mine started up again in 1956 has exceeded 23,000 flasks.

The Red Devil mine is located 251 miles west of Anchorage on the south bank of the Kuskokwim River. Annual mine production is approximately 4600 flasks which are flown to Anchorage and transferred to Seattle-bound ships. Although cheaper water haulage is available from Bethel, a port located 250 miles downstream from Red Devil, there are only two shippings scheduled each year—June and September. If the mercury were transported by way of Bethel, it would require about $750,000 to be tied up in inventory before the metal reached the market. During the past six years this could have resulted in substantial losses in a single shipment due to the declining market price. In addition, shipping mercury by air has made possible scheduled airline service from Anchorage twice weekly with its attendant advantages to the entire operation.

Red Devil mine (arrow) is located in Kuskokwim Mts.

GEOLOGICAL SETTING

The Red Devil mine is located on the western limb of an Upper Cretaceous anticline that has been subjected to several stages of faulting. The country rock, composed primarily of graded graywacke with some shale, is several thousand feet thick. The strata strike approximately N35°W and dip 55° to 70°SW at the mine site.

During Tertiary time, a major strike-slip fault developed across the anticline. The fault zone is approximately 50 ft wide and dips more steeply than the strata. Total displacement along this fault has not been determined.

Two andesite dikes, serving as the foci of mineralization, were subsequently injected along a tension joint system which is oriented normal to the anticlinal axis. These dikes, located about 1000 ft apart, cut diagonally across the fault zone for several hundred feet. They average 8 ft in width and dip 45° to the east.

After emplacement of these dikes, continued movement in the deep-seated fault formed suitable avenues along which penetrating solutions ultimately rose. This movement also formed a series of relatively minor bedding plane faults in the shaley layers spaced 5 to 10 ft apart in the graywacke beds. These faults caused individual displacements ranging from a few inches up to 120 ft, and cut the dikes into about 30 sections having a total strike-slip displacement of several hundred feet. The individual slips in the 5-ft to 20-ft offset range formed the most favorable openings for mineral deposition, and about 12 of these located on each dike constitute the principal ore shoots. Although these particular ore shoots only occur along 250 ft of the footwall of the main fault zone, additional mineable ore is found along the fault for a distance of 1200 ft. In places the ore zone attains a width of 300 ft.

Until geological studies determined that the ore shoots were orientated along a plane plunging 38°, staying on small erratic shoots proved very difficult. The individual shoots do not inter-finger or otherwise reveal their presence in the rock to a sufficient extent to be helpful in exploration.

MINING OPERATION

Since the present company started operating the mine in 1956, most of the ore has come from below the 150 level. Levels are spaced at 150-ft intervals, and an inclined shaft now reaches to a depth of 600 ft.

The narrow width, short strike length, and plunge of the orebodies makes their mining inherently costly. For the most part, sulfides occur in veins varying in width from 3 to 10 in. and in length from 5 to 25 ft. It is necessary to drive 1 ft of raise for every 2.5 tons of total ore mined. Of this amount, only 1.5 tons of ore are mined from the stopes for each foot of raise, resulting in a ratio of 1:1½ for development ore against stope ore.

After an orebody has been opened by a raise, stoping progresses downward. Stoping widths, which vary from 3 to 6 ft, are controlled by the distance to the first firm hanging wall, usually a graywacke bed. Although the ground is not heavy, the tendency of the hanging wall to slab necessitates considerable quantities of timber. Placement of this timber amounts to about 25% of the direct labor costs incurred in the stopes.

Removing ore from stopes has proven to be the most expensive operation in stope mining. Water and hand mucking are required to accomplish the job because the shallow plunging orebodies are not steep enough for ore to fall by gravity nor large enough to warrant the installation of slushers.

Machine loading of stope ore off the level floor shows a cost advantage over chute loading for small stopes, but it can seldom be used due to blockage of the gangway passage. Divided raises for manways and chutes are carried only far enough above the levels to allow for storage of a few cars of muck. Tramming is done with both air and battery trammers pulling one-ton dump cars.

During the summer months, mine water may exceed 100 gpm, whereas in winter it decreases to about 50 gpm. Nearly all of this comes from above the 450 level where it is collected in an abandoned drift and pumped from the mine. The pumping station has a pair of split case, two-stage Fairbanks-Morse pumps driven by 100-hp totally enclosed motors. Water entering the 600 level is pumped to the 450 level sump with a 15-hp Johnson sinking pump.

The mine is serviced by a one-ton capacity skid-mounted skip, handled by a 100-hp Vulcan Denver hoist. For six months of the year, ore and waste can be dumped into 60-ton capacity bunkers, but freezing conditions during the other months requires emptying the skip directly into a 6-yd truck. In cold weather, about 5 lbs of calcium chloride are sprinkled on the empty truck bed to prevent the ore and waste from freezing to the steel during the 30 to 40 min required to fill the truck.

MILLING OPERATION

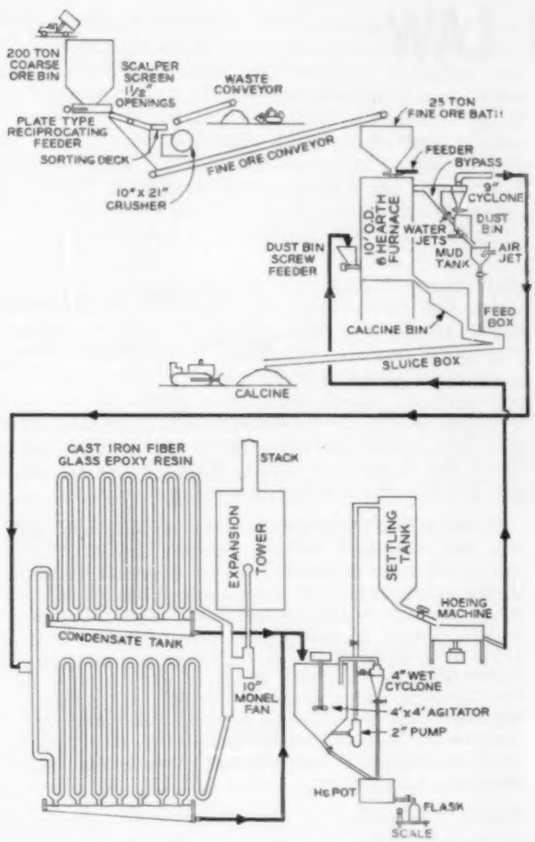
Ore is trucked ¼ mile from the headframe to the reduction plant. A 500-ton ore silo receives ore directly from the dump truck. A plate-type reciprocating feeder discharges the ore onto a vibrating scalper screen with 1½-in. openings. Oversize flow is controlled by a baffle arrangement that allows possible waste to be diverted to a sorting deck by the crusher operator. This operator has adequate time to sort these pieces while maintaining maximum capacity in the 10x21-in. jaw crusher. Waste is discharged onto a belt conveyor after it is washed by a high pressure air-water spray gun. This arrangement makes possible 7% to 10% waste removal at no additional labor cost. Screen undersize and crusher product are combined on a 70-ft conveyor belt which discharges into a 25-ton fine ore bin mounted directly above a six-hearth Pacific Foundry furnace.

MERCURY RECOVERY PRACTICE

Although the metallurgy of quicksilver ores is standardized in both rotary and hearth-type furnaces, operation of the Red Devil plant varies considerably from the accepted practice. The principle reason for this situation is the high stibnite-orpiment-realgar content of the ore which, in fact, exceeds the cinnabar content.

These antimony and arsenic sulfides sublimate to oxides in the same temperature range that cinnabar breaks down into mercury. These sublimates enter the gas stream with the vaporized mercury but, unlike mercury vapor, do not condense in the true sense of the word. These finely divided sublimates from the stibnite, orpiment and realgar tend to cling to all surfaces in both the hot and cold end of the gas circuit. This clinging tendency is so strong that even the cyclone, which is operated at considerably higher draft differential than common practice, is rapidly coated with this dust on surfaces where high speed gas velocities ordinarily would cause severe erosion. It was necessary to build an extra heavy 9-in. cyclone to withstand the hammering required to keep the interior clean. Frequent blowing with air through numerous strategically located hand holes is also required.

The most serious problem caused by these gangue minerals occurs in the furnace itself. The temperature which standard practice for hearth furnaces requires to be at minimum for mercury ores, melts the oxides of antimony and arsenic. To go above



Flowsheet of unique metallurgy process at Red Devil.

this temperature of about 1100°F invites disaster because antimonial and arsenal glass will coat the furnace interior, rabble arms and teeth. A surge of high grade ore will cement the entire bedding on the hearths to a solid mass of clinker, eventually breaking the rabble arms and teeth.

This difficulty is minimized by operating the furnace discharge at 1050° F. This temperature is sufficient for complete reduction of the ore, providing the retention time in the furnace is somewhat longer than standard practice. This is achieved by a slightly slower speed on the furnace shaft and a considerably higher gas outlet temperature of 650° to 700°F. In other words, the ore is heated faster and the maximum heat held longer. Even with these precautions, a great deal of slagging occurs in the furnace because the temperature near the burners must be well above the fusion heat of these oxides in order to achieve a generally lower heat throughout the hearth. Frequent shutdowns for furnace cleanouts are required.

As shown in the flowsheet, burned ore goes to a bin and thence by gravity to an enclosed feed box at the head of a 100-ft long, 7x10-in. sluice box. When the calcine bin requires emptying (about every 30 min), the mill operator opens the sluicing water valve and the discharge flows over a 15-ft high bank to a creek. Feed rate is automatically controlled by an arrangement that permits the burned ore that is sluiced away to be continually replaced by gravity flow and yet maintain a seal of burned ore in the discharge pipe. Sufficient calcine is always left in the bin to form this seal so as to keep the air entering the furnace from this source to a minimum.

The 9-in. cyclone feeds to the condensate tank. Waste for the cyclone goes to a dust bin and is discharged with the aid of water jets. The discharge bin uses a water seal instead of the conventional slide gate.

As mentioned previously, the antimony and arsenic sublimates do not truly condense, but they do flocculate in the condensers as they cool. Great amounts of these oxides accumulate in the condenser launders along with the mercury. Because of the predominance of these oxides, the condenser mud (or "soot") is light gray in color and, even when treating a relatively high grade ore, shows no free quicksilver.

The usual method of treating this product is either by hand or by mechanical hoeing. In the latter method, quicklime is added to dry the soot and to aid in cleaning the mechanically-held free quicksilver. After hoeing is completed, the dried mud must either be retorted or returned to the furnace. Hoeing leaves a residue that contains 30% to 40% mercury. The affinity of the finely divided oxides for mercury is so great that coalesence is quite impossible beyond a 30% content.

This problem was solved in 1959 by processing batches of wet dilute soot in a wet cyclone. As shown in the accompanying flowsheet, the watery mud is sent from the condenser launders into a 4x4-ft conical-bottomed agitator. This agitator has water jackets through which the slurry is heated to 100°F by emersion heaters for a 24 to 48-hr period. Mounted on the side of the agitator is a 4-in. Krebs cyclone and a 2x2-in. Denver SRL pump. The bottom of the agitator cone is connected to the mercury pot through a goose-neck and valve which allows a pool of mercury to always be retained in the base of the agitator. Some mercury separates in the agitator and is drawn off through this pipe. Four inches above the goose-neck level is a 2-in. outlet for the pump intake. The pump receives its feed from this pipe and delivers it back into the top of the agitator through the cyclone. Pulp density is not critical, as the cyclone operates satisfactorily through a wide range.

The cyclone, if operated in the conventional manner, produces a thickened, heavy mud. When the flow of mud is stopped, free mercury accumulates at the base of the cyclone. By maintaining a small pool of mercury in the base of the cone, the apex is effectively sealed to prevent anything but free mercury from escaping. The size of this pool is controlled visually through a short section of clear plastic tubing. At the end of the tubing, a full-flow pinch valve used for controlling the flow is regulated to keep free mercury visible in the plastic tube. At the beginning of a batch run, mercury discharges at a rate of several flasks per min, but this slows down to a mere trickle after approximately 3 hr.

The impoverished mud is then transferred by the cyclone pump to a vertical 3x12-ft settling tank. The thickened mud from this tank is discharged through a 4-in. plug valve directly into the hoeing machine used to dry the mud. The dried mud, which contains about 10% free mercury, is fed back into the furnace through a self-sealing screw conveyor.

As can be seen, the mining and metallurgy of this deposit have presented greater problems than the more common ones of the far north.

ALASKA'S NEW MINING LAW FOR STATE LANDS

by JAMES A. WILLIAMS

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The story of the development of Alaska's new mining law for State lands begins with two documents which established the basic framework and guidelines for its evolution. These are the Alaska Constitution, adopted by Alaskans back in 1956 but not effective until the attainment of Statehood on January 3, 1959, and Public Law 85-508, the Statehood Act.

Sections 11 and 12 of Article VIII of Alaska's Constitution provide the following stipulations:

> "Section 11. Discovery and appropriation shall be the basis for establishing a right in those minerals reserved to the State which, upon the date of ratification of this constitution by the people of Alaska, were subject to location under the federal mining laws. Prior discovery, location, and filing, as prescribed by law, shall establish a prior right to these minerals and also a prior right to permits, leases, and transferable licenses for their extraction. Continuation of these rights shall depend upon the performance of annual labor, or the payment of fees, rents, or royalties, or upon other requirements as may be prescribed by law. Surface uses of land by a mineral claimant shall be limited to those necessary for the extraction or basic processing of the mineral deposits, or for both. Discovery and appropriation shall initiate a right, subject to further requirements of law, to patent of mineral lands if authorized by the State and not prohibited by Congress. The provisions of this section shall apply to all other minerals reserved to the State which by law are declared subject to appropriation.
>
> "Section 12. The legislature shall provide for the issuance, types and terms of leases for coal, oil, gas, oil shale, sodium, phosphate, potash, sulfur, pumice and other minerals as may be prescribed by law. Leases and permits giving the exclusive right of exploration for these minerals for specific periods and areas, subject to reasonable concurrent exploration as to different classes of minerals, may be authorized by law. Like leases and permits giving the exclusive right of prospecting by geophysical, geochemical, and similar methods for all minerals may also be authorized by law."

It was under the Statehood Act that Alaska received the right to select from vacant and unappropriated lands 102,550,000 acres and certain other small grants which will bring the total of State-owned lands up to more than 104,000,000 acres when the selections are completed about 25 years from now. It is important to note that these selections of land must be in large compact tracts of at least 5760 acres where possible, in contrast to similar grants to other States which usually consisted of only two or four sections from each township. In addition to these grants, the State received title to all tidelands, navigable water bottoms, and submerged lands within the three-mile limit. With regard to minerals, the Statehood Act stipulates:

> "Section 6 (i). All grants made or confirmed under this Act shall include mineral deposits. The grants of mineral lands to the State of Alaska under subsections (a) and (b) of this section are made upon the express condition that all sales, grants, deeds, or patents for any of the mineral lands so granted shall be subject to and contain a reservation to the State of all of the minerals in the lands so sold, granted, deeded, or patented, together with the right to prospect for, mine, and remove the same. Mineral deposits in such lands shall be subject to lease by the State as the State legislature may direct. . . . ."

Under the terms of the Constitution, discovery and appropriation are required for the establishment of mineral rights, including permits and leases, in locatable minerals. (This article is concerned only with those minerals which are locatable under the Federal Mining Laws, and not the Leasing Act minerals available only by leasing such as coal, oil, potash, etc.) The above section of the Statehood Act prevents the State of Alaska from giving or selling mineral rights with any of its granted land when it in turn sells, grants, deeds or patents this land to others. The section states that such mineral rights are subject to lease only. This prohibits issuance of mineral patents by the State. However, the Act does not prohibit the acquiring of mineral rights by staking claims on State-owned lands. The above, then, were the requirements and restrictions under which State laws and regulations for acquiring mineral rights on State-owned lands had to be promulgated.

PREPARATIONS FOR DRAFTING MINING LAW

The 1959 State Legislature provided the needed mining law for State-owned lands in Article IX of the State Land Act, which largely included the laws already in force on Federal public domain. As the State Administrative Procedure Act provided for the adoption of regulations to spell out and implement State laws, it was decided by the State Department of Natural Resources to draft regulations which would define and interpret the provisions of this mining law. This would define terms and insure better understanding and equal treatment for all concerned. A series of public hearings throughout the State was considered advisable to obtain the mining industry's opinions on the proposed regulations. Regulations were drafted following the gen-

erally accepted concepts of traditional mining law and well-known court decisions. Leasing provisions, where necessary, were provided. A provision for tripling assessment work requirements was inserted to "needle" the industry into taking notice of what was being done. Hearings were scheduled, advertised, and held during the winter of 1960-61. The Division of Mines and Minerals and the Division of Lands cooperated on this work under the direction of the Commissioner of Natural Resources Phil R. Holdsworth.

It quickly developed in the first hearing that, since a discovery (see "Mining Claims" below for definition of *discovery*) is positively required by the State Constitution, the industry wanted some sort of protection in the area of prospecting operations while the discovery was being sought. Noting that the Constitution allows for ". . . . exclusive right of prospecting . . . .", much discussion was held as to how much area for what period of time should be allowed for prediscovery protection. Opinions varied greatly, but nearly all present agreed upon the necessity for the protection.

In considering this possible addition to the existing mining law, it occurred to the hearing committee that here at the start of the new State operations was a rare opportunity to adopt regulations differing from traditional U.S. mining law in ways which many in the mining industry feel are necessary to spur development and keep pace with technological progress. The State Constitution and the Federal Statehood Act imposed certain restrictions as noted earlier, but the existing State law could be changed if the industry so wished and if the State would benefit. As a result, deviations such as 40-acre claims, no distinction between lode and placer, no extralateral rights, banking of assessment work, crediting of mobilization costs to assessment work, cash in lieu of assessment work, and other innovations were discussed in great detail at the hearings in addition to prediscovery protection. These possibilities were such a complete departure from the proposals as circulated and studied before the hearings, that the industry requested additional time to study and comment. Much study was given to the new proposals by both the industry and the Department. As a result of many more helpful statements from the industry by correspondence, a complete new set of regulations was drafted, incorporating what seemed to the Department to be the features that most of the testimony and correspondence favored, and which were also in the State's interest. The redraft was published and circulated, and more hearings scheduled.

The second round of hearings produced basic agreement among the various factions of the industry on what was wanted in the way of regulations for acquiring prospecting and mineral rights on State-owned lands. Individual prospectors, exploration geologists, mining engineers, consultants, and producing companies all participated. Following this, a bill was drafted to repeal the existing law and make legal the new features as jointly decided upon by the industry and the Department. The bill was passed and signed into law by Governor William A. Egan as Chapter 123, Session Laws of Alaska 1961. Following passage of the bill, the regulations were submitted to the Secretary of State for approval, and they were in due course made part of the Alaska Administrative Code. This "cart-before-the-horse" approach was novel, to say the least, but it was by far the best approach to a procedure whereby the industry and the Department could jointly determine what mining regulations were needed for progress in the State of Alaska, and then put them into effect.

PERTINENT PROVISIONS OF THE ALASKAN MINING LAW

It should be emphasized here again that these laws and implementing regulations are effective on State-owned lands *only*. They have nothing to do with Federal public domain lands, which will continue to include at least two-thirds of Alaska after State selections are completed, and on which lands Federal laws and a few older State laws will continue to govern. A problem arises, of course, if a prospector does not know if the land he wishes to stake is Federal public domain or State-owned land. This problem can be minimized if he keeps abreast of the land selection activities of the State Division of Lands. Information can also be obtained from the Land Office of the U.S. Bureau of Land Management as to State selections in a particular area. However, the claimant's mineral rights are in no danger if he stakes a claim under Federal procedures on State-owned land. Since claims located under Federal requirements are smaller than claims allowed on State lands, and recording procedures are similar, the State will recognize the claim so located if done properly, and the locator's mineral rights will be secure. He will lose only the benefit of the larger area for each claim so staked, and will not acquire extralateral rights.

Locations made on lands selected by the State from the aforementioned vacant and unappropriated acreage, but prior to the time the State receives tentative approval of the selection from the U.S. Bureau of Land Management, are made at the locator's risk. When the State receives tentative approval of its land selection, the locations will become valid and the State may issue conditional mining leases, subject to conditions of the tentative approval and land classification by the State. These rights will be lost, or partly lost, in the event the State does not eventually receive title or patent to all or part of the lands. A claim holder on Federal public domain cannot lose his mineral rights through State land selection, because the State cannot select land included within valid mining claims. Prospectors and locators are protected from being held to a letter-perfect compliance with the new law and regulations by a "substantial compliance" provision.

An estimated 10% of the State's lands will be so classified that claims may not be staked. Minerals on these lands will be available for mining under lease. Leasing terms were made as lenient as practicable to encourage new mining operations. Royalty requirements were omitted under the premise that the State would amply benefit from additional development and payrolls without the possibility of discouraging new operations with further expense. Leases, permits, prospecting sites, and extensions are granted and administered by the Division of Lands with the technical guidance and approval of the Division of Mines and Minerals.

Mining Claims: Mineral rights are initiated by discovery, location and filing. *Discovery* is defined in the State regulations as "such a finding of valuable mineral as would justify an ordinarily prudent person in expending further time, labor, and money upon the property with a reasonable expectation of developing a paying mine." There is no distinction

between lode and placer claims, and there are no extralateral rights. Mining claims may be a maximum of 40 acres and may not exceed 1320 ft on a side. Claim boundaries are to be staked N-S-E-W where practicable and are to be plainly marked on the ground. Posts or monuments are required at the corners, and witness posts may be used where corners are inaccessible. The location notice is to be posted on the northeast corner of the claim. Boundaries, posts and notices must be kept clearly marked and properly maintained for the life of the claim. If not, the claim will be considered abandoned. Claims may be staked on unclassified lands and on lands classified as grazing, material, mineral or timber lands. Claims may be staked on tidelands and navigable water bottoms, as well as uplands, when in one of the foregoing categories. Surface and timber uses on a claim are limited to those necessary for prospecting and mining. Ninety days are allowed for filing the certificate of location. The location notice and certificate must contain approximately the same information as those for a location on Federal land, with the addition of the names, signatures and mailing addresses of the locators.

Annual Labor: Annual labor (assessment work) must be performed and affidavits recorded in the traditional manner. At least $100 worth of acceptable work is required for each claim. The work required does not have to be done within a claim, but the regulations state that it "must benefit or develop the claim toward the extraction or removal of ore or minerals or facilitate such extraction or removal." Work may be done in one place for adjacent claims of common ownership. The regulations state further that no credit shall be allowed for transportation of men or equipment to or from the claim, and that credit shall be allowed for drilling and excavating, including ore extraction; or geological, geochemical or geophysical work under the same circumstances as in the Federal law. Assessment work must be done within each assessment work year. Provisions for banking of assessment work (doing several years' work during one year) and paying cash in lieu of the work were not adopted. The assessment work year begins and ends at noon on September 1. Assessment work affidavits may be filed for record at any time after completion of work until 90 days after the expiration of the assessment work year. Failure to file before the termination of this time limit constitutes abandonment, and the claim is then open to location by others.

Mining Leasing: As with claims, prior discovery, location and filing initiate prior rights to the leasing of locatable minerals where lands are open to mining leasing, except on submerged lands. All lands open to claim staking are also open to mining leasing. Lands open only to leasing are those classified as follows: agricultural, commercial-industrial, private recreation, public recreation, residential and reserved use. Leasehold locations are made and certificates filed in the same manner as with claims, and the maximum dimensions of each are identical. Where lands are open to leasing only, a lease application must also be filed upon request of the State Division of Lands. A valid mining claim may be converted to a leasehold at the owner's convenience, if he so wishes. Lease rental is $100 per year per leasehold. Cost of development work that would qualify for annual labor for a mining claim may be applied as a credit against the rental. Failure to pay the rent or file the work statement before the end of the 90-day period terminates the lease and leasehold. Mining leases are for a maximum of 55 years, with the State reserving the right to reasonably adjust the rental rate at the end of each 20-year period, based on changing production and market conditions. This adjustment may be either up or down. No royalties are required. Lease assignees or transferees are responsible directly to the State for the performance of lease obligations, not to the assignor or transferor.

Prospecting Sites: "Prospecting Site" is the name given to the area within which prediscovery protection can be obtained under the proper circumstances. As quoted from the regulations, "Prospecting sites are intended to provide prediscovery protection to prospectors in areas where depth of cover, or other factors, makes necessary considerable work in order to make a discovery. Prospecting sites may be located and utilized only for the purpose of mineral discovery and for locating mining claims or leaseholds." The prospecting site holder has the exclusive right to use the surface within the boundaries for performing prospecting work and for staking claims leaseholds. Prospecting sites are optional—they are not required for the purpose of prospecting on State land. The site may not include the claim of another. The maximum size of a site is 160 acres, and it cannot be more than 2640 ft on a side. The boundaries must run N-S-E-W where practicable, and colored markings sufficient to allow easy tracing of the boundaries and distinguishing of the corners on the ground are desirable. Corner posts or monuments are not required. A location notice must be posted at the northeast corner, and location certificates must be filed with the proper recorder and the State Division of Lands within 90 days. No person may locate more than six sites per year per recording district, but sites can be sold or transferred. Prospecting sites remain in effect only one year, but under certain conditions, one-year extensions may be granted upon application. Acceptable prospecting work amounting to at least $5 per acre must be performed during the year, and also during the first extension. If further extensions are granted, the amount required is $10 per acre. Acceptable prospecting work is limited to drilling or excavation; or geological, geophysical, or geochemical work by qualified persons. As with claims, work may be done on one location for a group of adjacent sites held in common ownership. A request for extension of a site must be accompanied by a signed statement of work done. Expired sites may not be restaked by the locator or his successor in interest within a two-year period, but he is not prevented from locating a claim or leasehold there in the absence of intervening rights.

Submerged Lands: Submerged lands (low tide line to the three-mile limit) are open to leasing only. Offshore prospecting permits are provided for, and they give the holder a right to a mining lease if he finds workable mineral deposits. An offshore prospecting permit may cover a maximum of 5120 acres in a reasonably compact form (length not more than four times the width), and is granted for two years with a single two-year extension provided for if warranted. Submerged lands containing known deposits may be offered for lease by competitive bidding. Rental for offshore leases is $1.00 per acre per year, and expenditures on or for the benefit of the leasehold are creditable against the rental. No royalty is required.

ECONOMIC ASPECTS OF ALASKAN MINING

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Prior to World War II, the Alaskan economy was typically colonial. Out-shipments were composed primarily of canned salmon, gold and silver, and furs and skins. Annual in-shipments were equal in value to half the out-shipments, and were composed primarily of salmon canning supplies, petroleum products, whiskey and other alcoholic beverages, foodstuffs and various manufactured items. This pattern was disrupted by the entrance of the U.S. into World War II in 1941. Alaska's strategic location astride the Pacific Ocean caused it to become one of the principal defense bastions of the "air age." Military personnel stationed in the Territory rose from 524 persons in 1939 to 152,000 by 1943. This increase was accompanied by a rise in construction activity, primarily for defense, including roads, airfields and communication facilities. The construction industries were responsible for the employment of approximately 1300 persons in 1940; by 1941, this figure had jumped to more than 13,000. Since the War, the Alaskan economy has had a boom-or-bust character, the peaks and valleys of which have coincided with the ups-and-downs in military appropriations.[1]

The Federal Government, exclusive of Government-sponsored construction, is still the primary "industry" in the new State. Approximately 60% of both total wages and employment, including the military, is derived from "Uncle Sam." Excluding the military, the Federal Government is responsible for 34% of total wages and 38% of total employment in Alaska.*

The Alaskan economy, however, is now in a state of flux; the Alaskan economic revolution is continuing. Table I indicates the changes taking place as represented by the trend of employment in various industries covered under the Employment Security Act. Studying the statistics shown in this table reveals that, within the manufacturing segment, salmon canning had declined from 15% of total wages in 1950 to less than 10% by 1958; the lumber and pulp industries have increased from 2% to 5%. Service industries, however, have exhibited the greatest growth, going from 30% to 45% of total wages.

* Based on data from the Employment Security Division, Alaska Department of Labor.

Table I. Employment by Major Industries Covered by the Employment Security Act, 1950-58

Year	Mining	Construction	Manufacturing	Transportation and Utilities	Trades, Services, and Other	Total
1950	1,869	6,226	5,733	3,449	7,931	25,208
1951	1,637	10,492	6,109	4,125	10,242	36,605
1952	1,743	9,829	5,990	4,218	11,102	32,882
1953	1,627	8,676	5,239	4,409	10,667	30,618
1954	1,384	7,380	4,369	4,064	10,134	27,281
1955	1,343	6,413	4,952	4,618	11,437	28,763
1956	1,224	7,428	5,004	4,709	12,128	30,493
1957	1,290	5,863	4,786	5,079	12,507	29,525
1958	1,241	5,599	4,844	4,841	12,340	28,865

Although the mineral industry remained relatively stable during the 1950 decade on the basis of value, this is not to imply that it has been stagnating. In reality, it too has been undergoing change. This is best shown by the data in Table II. It will be noted that the value of gold production dropped 30% from 1951 to 1960, while coal and sand and gravel increased 68% and 47%, respectively, in the same period. The decline in gold output resulted from a lack of incentive to produce because of rising costs and the fixed price of $35 per ounce, as well as from a decline in reserves. The rise in coal production was caused primarily by the expansion of military central power plants and construction of new military installations (such as the Clear Ballistic Missile Early Warning Station). The rise in sand and gravel output paralleled the increase in construction activity (estimated at $78 million in 1950 and $157 million in 1959).

The brightest facet in the Alaskan mineral picture today is the petroleum and natural gas industry. Oil was first discovered on the Kenai-Moose Range, Kenai Peninsula, in 1957, by the Richfield Oil Co. Subsequently, an agreement between Richfield and Standard Oil Co. of California made Standard the operator of the Swanson River Field. In 1959, the first commercial gas field was discovered by Union Oil Co. of California, also on the Kenai Peninsula. There are now three gas fields on the Peninsula.

Table II. Value of Mineral Production, 1951-60, and 1946-50 Average, by Major Commodities[1] (Thousand Dollars)

Year	Gold	Coal	Sand and Gravel	Petroleum and Natural Gas	Other Minerals	Total
1946-50 average	$8,917	$2,808	[2]	—	$3,737	$15,462
1951	8,387	3,767	$3,739	—	3,676	19,569
1952	8,420	5,779	8,651	—	3,452	26,302
1953	8,882	8,452	5,080	—	1,838	24,252
1954	8,698	6,442	6,302	—	2,965	24,407
1955	8,725	5,760	8,242	—	2,685	25,412
1956	7,325	6,374	5,880	—	3,829	23,408
1957	7,541	7,296	8,799	—	5,156	28,792
1958	6,525	6,931	3,871	[3] 6	4,117	21,450
1959	6,262	5,869	5,265	311	3,788	20,495
1960	5,887	6,318	5,483	1,260	2,914	21,862

[1] Adapted from data in U.S. Bureau of Mines *Minerals Yearbooks, 1946-60.*
[2] Included with "Other Minerals."
[3] Incomplete total; value of crude petroleum included with "Other Minerals,"; only natural gas value shown.

These discoveries were followed by construction of an oil pipeline from the Swanson River Field to tidewater on Cook Inlet (completed 1960) and a gas line from the Kenai unit near Kalifonsky Beach to Anchorage (completed in the summer of 1961).

The growth of the petroleum industry is shown by the fact that only 780,000 bbls of petroleum had been produced from the year of discovery (1957) to January 1, 1961; from January 1, 1961, to June 1, 1961, a total of 1,600,000 bbls was produced. It is estimated by the Division of Mines and Minerals, Alaska Department of Natural Resources, that about 600 persons are employed by the petroleum industry with an annual payroll of $5 million; 18 companies are active in Alaska and more than $100 million has been expended for exploration and development in the last ten years.

With the exception of petroleum, little has been done in recent years to exploit the mineral resources of the 49th State. In an area one-fifth the size of the 48 southern States, only one hard-rock underground mine (Red Devil) is active; metal exploration and prospecting expenditures by major companies averaged approximately $1 million annually in the 1955-59 period. Expenditures in 1960 were estimated at $2 million. In view of the great quantity of literature extolling the vastness of Alaska's mineral resources, one may properly ask why exploitation has been so slow. The answer seems to lie in the geography of the State and the resulting economic and climatic problems.

ECONOMIC FACTORS AFFECTING THE MINERAL INDUSTRY

Labor: Wage rates in Alaska range from a low of $1.90 per hour for cooks and laborers to a high of $4.67 for coal mine machine operators. The general average rate for miners is estimated at $3.50 per hour. One company[2] estimated that mine labor would cost about 25% above the normal stateside rate. Average monthly earnings in the mineral industry covered by the Employment Security Act were calculated at $747 in 1960 (coal mines—$926; oil and gas—$806; other—$620) compared with a U.S. average of approximately $430.

Transportation: Transportation facilities in Alaska are limited and expensive, primarily because of the location, size and topography of the State. This is not necessarily a major obstacle to mineral resource development; transportation will generally follow a major discovery. Witness the development of the Kennecott mines of the Copper River Basin in the early 1900's or the Labrador and Venezuelan iron deposits in more recent times. In the case of these mines, railroads were built from Tidewater to the ore deposits, harbor facilities were constructed, and towns sprang up in the wilderness.

For the mine not quite up to bonanza standard, however, transportation can be a crucial factor. The experiences of Earl R. Pilgrim will serve as an illustration. In 1956, Mr. Pilgrim made two shipments of antimony ore from his Stampede mine in the Kantishna district, Yukon River region. The first shipment, consisting of 30 tons, was hauled from the mine to Lignite, on the Alaska Railroad, by tractor train, shipped by rail to Seward and then by coastwise ship to Seattle, and transferred at that port to an ocean-going vessel bound for Kobe, Japan. The second shipment was flown from Stampede to Nenana, shipped by rail and steamship to San Francisco, and then forwarded to Baltimore, Md., by way of the Panama Canal. The cost of these two shipments was $72.70 (excluding tractor-train expenses) and $122.22 per ton, respectively.[3] The cost of the 50-mile tractor-train trip was not calculated by Mr. Pilgrim. However, the cost of using tractors has been estimated by Ted C. Mathews in a paper presented before the Third Annual Mining, Minerals and Petroleum Conference in April 1958, at College, Alaska. Mr. Mathews estimated the cost on a predominantly ice road during the winter at 25¢ per ton-mile; in hilly foothill country this would increase to $1.00 per ton-mile. In those areas of Alaska where the country is timbered and there are many stream crossings, tractor-freighting costs will vary from $1.00 to $1.50 per ton-mile, exclusive of clearing costs; the latter costs may average $300 per mile.

The use of tractor trains for bulk haulage would be necessary in many cases, since the State has a total of only 5200 miles of connected road. This is approximately nine miles of road per 1000 sq miles, compared with an average of 850 miles of highway per 1000 sq miles in Texas. Costs would decline if a highway were available, but would still be relatively high. Truck rates on the Alaska Highway range from 7¢ to 11¢ per ton-mile.[4]

Rail rates in Alaska also are high. The Government-owned Alaska Railroad has an average ton-mile revenue of 5.7¢ compared with the U.S. railroad average of 1.4¢.

The steamship rate for southbound ores and concentrates from Seward to Seattle is $17.00 per ton, or 1.4¢ per ton-mile; general cargo, northbound, would bear a much higher rate. In addition to the ship transportation cost, wharfage and handling charges would have to be added. These have been estimated at 26% of total transportation costs from Seattle to Alaska. Wharfage and handling charges in Alaska would generally be 55% greater than in Seattle; this results from higher Alaskan wages and the lack of regulation and uniformity among dock companies.[5]

Some savings in ocean shipping costs would be possible through the use of chartered tugs and barges. The charter fee for one tug and a 2500-ton barge is estimated at $40,000 per month. Assuming two round trips per month, the ton-mile cost for hauling ore, exclusive of wharfage and handling, would be 8 mills. In those instances where shipments could be maintained throughout the year, rates as

low as $17,000 for the tug and $1200 for each 2500-ton barge might be obtained. Single round-trip charters are available for $1500 per day.[6]

The high cost of transportation results primarily from the lack of southbound cargo. Except in the salmon canning season, northbound cargoes make up 75% to 90% of total ocean revenue tonnage.

The Japanese had announced that freight rates from Japan to Alaskan ports would average 30% more than rates for similar items delivered to other west coast ports. The differential has only recently been removed.

The failure of the Alaskan hinterland to generate freight for southern points is symptomatic of the lack of industrial activity, capital and people.

Taxes: Taxes levied by the State on the mineral industry appear higher than those levied by other States. The corporate income tax in Alaska has an estimated effective rate of 9% (nominal rate is 18% of computed Federal income tax on Alaska income). There is also a mining license tax which, in effect, is a net income tax. This is levied at the following rates:

Net income under $40,000—no tax

Net income $40,000 to $50,000—3%

Net income $50,000 to $100,000—$1500 + 5% of excess over $50,000

Net income over $100,000—$4,000 + 7% of excess over $100,000

In lieu of the mining license tax, petroleum and natural gas producers pay a gross production tax of 1% on the well-head value of oil and gas produced and a conservation tax of 5 mills per bbl of petroleum or 50,000 cu ft of natural gas marketed.

All mineral producers are required to pay an unemployment compensation tax; this varies from 1.5% to 4%, the applicable rate being determined by quarterly payroll decline. The taxable salary limit per person is $7200 per year.

There are, however, certain exemptions provided the mineral industry from all the above taxes. Depletion allowances similar to Federal allowances are permissible in calculating net income. In addition, mining companies entering business in Alaska pay no license tax during the first 3½ years of operation. Of greater importance, perhaps, is the industrial incentive exemption. Under this act, the State can exempt any new business or industry from all State and local taxes up to a period of ten years, based on the capital investment within Alaska. The exemption ranges from a five-year period for a $1 million investment or less up to a ten-year exemption for capital investments in excess of $10 million.

Table III. Per Capita General Revenue for the Northwestern United States, by States, 1958[1]

State	From Federal Government	From State Sources	Total
Alaska [2] 1958	$126	$129	$255
Alaska [3] 1961	269	140	409
Idaho	39	195	234
Montana	48	238	286
Oregon	43	245	288
Washington	41	243	284
Wyoming	123	281	404
U.S. Average	28	210	238

[1] From *Statistical Abstract of the United States*, 1960, p. 410, except Alaska.
[2] Calculated by author.
[3] Calculated by author; given to show impact of Statehood.

In order to determine the comparative tax position of Alaska, it is useful to compare per capita general revenue with that of other Pacific Northwest States (Table III). General revenue is total revenue accruing to a State except for income from Government-owned utilities, liquor stores, and insurance trusts.

Per capita revenue in Alaska since Statehood is considerably higher than that of any other State; however, the bulk of the income is from Federal sources. It appears, therefore, that as a result of heavy Federal subsidization, the new State's taxes are no higher on a per capita basis than those of its sister states to the south.

Projecting ahead (Table IV) and assuming that petroleum production will be at least 6.5 million bbls annually by 1966 and income from bonus bids will average $7 million each year, we find the State suffering deficits only in 1964 and 1965. If the assumptions regardir„ growth of the mineral industry are correct, there should be no need for substantial increases in taxes.

In a paper prepared in November 1960, the author predicted a cumulative tax deficit of $35 million by 1966.[7] This figure, however, was based on considerably slower growth for the petroleum industry, as well as much lower land revenue. The more optimistic outlook seems warranted by the greatly increased oil output in the past year, plus rising bonus bid income from State mineral lands. In May 1961, Alaska received $7,170,605 from a single competitive lease sale. From October 1958 to May 30, 1961, the State realized over $23 million from its oil, gas and coal resources.

Table IV. Estimated Annual Receipts and Expenditures, 1960-66[1]

(Thousands of Dollars)

Fiscal Year Ending June 30	Nonmineral State Receipts[2]	Mineral State Receipts[3]	Federal Grants	Total Receipts	Expenditures[4]	Cumulative Surplus or Deficit
1960	$27,200	$11,100	$27,600	$65,900	$56,400	+$9,500
1961	28,300	9,800	57,400	45,500	99,800	+5,200
1962	29,500	19,000	65,400	113,900	110,600	+8,500
1963	30,200	23,000	53,300	106,500	110,500	+4,500
1964	29,400	29,000	51,800	100,200	108,400	−3,700
1965	31,000	32,000	49,300	112,300	110,200	−1,600
1966	32,000	36,000	48,000	116,000	107,000	+7,400

[1] Adapted from State of Alaska Capital Improvement Program 1960-66, Alaska State Planning Commission, January 1960, and Budget Document, 1960-61, State of Alaska, except as noted.
[2] Adjusted to reflect increased taxes.
[3] Estimate by the author; includes lease rentals, severance taxes, land bonus bids, and royalties.
[4] Adjusted to reflect changes in matching fund requirements under the Federal Aid Highway Act of 1960

Even if the less optimistic prediction were to come true, and assuming an increase in taxes resulting in a balanced budget, total per capita State revenue in 1966 would increase to $460. Only $164 would be raised from State sources, the remaining $296 per capita being derived from the Federal Government. The $164 per capita from State sources would be 16% below the 1958 figure for Idaho, lowest of the northwestern States in per capita revenue from State sources.

Capital Costs: Capital costs are estimated by Bear Creek Mining Co. (one of the exploration companies now active in Alaska) at 70% above those in the U.S. The higher capital costs result from high construction labor wages, plus freight on materials, as well as from greater capital requirements because of the need for housing and utilities able to withstand the rigorous climate. C. D. N. Taylor, in a paper presented before the AIME at Anchorage, Alaska, in April 1959, stated that more than 38% of the capital outlay at one producing property in northern Canada was required for construction of bunk houses, cafeterias, central heating plants, domestic water plants, and exterior pipelines. Since this operation is active throughout the year, precautionary features had to be constructed, such as special insulated pipe boxes for utility lines and other items. The cost of heat alone was estimated at 75¢ per day per person, or $1.14 per ton of ore (500-tpd operation.).

Higher costs also result from seasonality (short work season). In 1960, Alaska's mines, principally placers, operated an average of only 159 days. This short working season, resulting from climatic and geographic factors, means higher costs because of heavy capital investment tied up unproductively for a considerable portion of the year. Climate and location mean higher costs for operations active throughout the year because of the need to stockpile ample supplies before the winter season with its short days and consequent restricted flying time.

The Bear Creek Mining Co. estimated that overall costs in Alaska for operations having access to water transportation would be 1.5 times those of a comparable operation in the southern 48 states.

Other Problems: Alaska, as a result of limited market potential far from distribution centers, suffers from shortage of local investment capital. Total capital, surplus, undivided profits and reserves for the 18 banks in the new State are the smallest of any State in the nation. This means that the mineral prospect must be large enough and rich enough to attract investors in New York, San Francisco, Seattle and other investment centers. There is little opportunity for the small prospect to obtain the risk capital necessary to become a small mine.

Another problem is population concentration. More than 60% of the people of Alaska reside in the Anchorage-Fairbanks area. Consequently, roads are built from a market place into an undeveloped hinterland, and thus do not pay back the cost of construction through gasoline and business taxes for some years. The lack of highway revenue coupled with construction difficulties, such as permafrost, muskeg and rugged topography, results in less road mileage per dollar expended. Population concentration can also result in considerable pressure being brought to bear on State officials for the expenditure of a disproportionate share of available funds on wider and better paved roads, expressways and other urban facilities, rather than on development highways and other long-range items.

Another factor in the Alaskan economic picture is that of imports. The effect of imports and exports on the mineral industry is difficult to determine because of the lack of detailed data. It would seem, however, that mineral imports in the decades ahead should grow because of generally lower prices for equal quality coupled to Alaska's strategic location in relation to Asia. The latter results in low-cost water transportation.

The establishment of some local mineral industries may suffer from increased imports, but generally, imports should be beneficial. Importation of mineral and other commodities should result in increased local industry by reducing the cost of living. It is interesting to note that mineral imports, primarily from Japan, increased ten times in the 1955-58 period. Imports and exports doubled in the second half of the 1950 decade compared with the first half.

CONCLUSION

High costs, limited transportation facilities, lack of skilled labor and limited local investment capital plague the development of a mineral industry in Alaska. These difficulties, however, are the usual problems facing mineral producers in undeveloped areas. They are, in the case of Alaska, compounded by climate, location, size and rugged topography. We have but to look at Canada and Scandinavia to recognize that these difficulties are not insurmountable. Iron ore, coal, copper, uranium and other commodities are being mined north of the Arctic Circle in these countries. In each case, however, the ores are of high grade with ample reserves. The Scandinavian nations, in particular, appear to have reached their present state of development because of proximity to a heavily populated region providing an excellent market place, and because of their hydropower resources.

Given a continued high worldwide demand for raw material, there is no reason why Alaska should not be able to eventually equal the advances made in Canada and Scandinavia. The inevitable northward migration of people and industry will, in time, solve most of the problems presently impeding Alaska development.

It is interesting to note that Alaska is one of the last remaining areas of huge, undeveloped, inexpensive, hydroelectric power. The Rampart Canyon site on the Yukon River, alone, has an estimated capacity of five million kw—more than twice that of Grand Coulee. Preliminary estimates indicate that this power will ultimately be sold at the Gulf of Alaska for three mills. The eventual availability of this huge block of power will serve as a magnet for industry. With the electric-process industries will come roads; with the construction of roads will go the "Last Frontier."

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FEDERAL, STATE ACTIVITIES

U.S. Bureau of Mines Program in Alaska

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The U.S. Bureau of Mines mineral resources program in Alaska is directed by the Alaska Office of Mineral Resources (shown above) working under the general supervision of the Bureau's Regional Office of the Division of Mineral Resources at Albany, Oregon. Health and Safety Activities, including coal mine inspection, are directed from District H headquarters in Denver, Colo. In addition to offices and laboratories located in Juneau, the Bureau maintains a field office and a coal analysis laboratory in Anchorage, where the coal mine inspector also is headquartered. From 28 to 30 full-time employees and from 12 to 15 seasonal or part-time workers are required to conduct the program.

With the exception of health and safety work, part of which is regulatory, the USBM program in Alaska is chiefly concerned with mineral resource appraisals and economic studies which are published variously by the Bureau of Mines as *Information Circulars, Bulletins, Reports of Investigations, Area Reports*, and a chapter in the annual *Minerals Yearbook*.

INVESTIGATIONS OF MINERAL DEPOSITS

Investigations of mineral deposits (including mineral fuels) are conducted with funds appropriated by the Congress to the Bureau of Mines for the "Conservation and Development of Mineral Resources." The language of the authorization directs the USBM to make scientific, technologic and economic investigations concerning the extent and mode of occurrence, the development, mining, preparation, treatment and utilization of ores and other mineral substances found in the U.S. or its Territories or insular possessions, which are essential to the common defense of the industrial needs of the U.S. etc.

In general, the Bureau's mineral investigative program in Alaska is coordinated with—but does not duplicate—the work of the U.S. Geological Survey. In nearly all current field investigations, the work consists of detailed mapping and sampling with such trenching, drilling or other standard procedures as may be necessary for preliminary appraisal. The principal programs currently authorized are briefly outlined by commodities.

Ferrous Metals: This program provides for investigation of iron deposits throughout Alaska by means of preliminary surveys of promising new or undeveloped mineral occurrences including preliminary sampling, related laboratory investigations, and such pioneering work as is necessary to provide information and assemble data for proposals for more comprehensive study of significant deposits. Work has been done and factual data have been published on iron deposits at Klukwan, Snettisham, and on Prince of Wales Island. Current project activity is confined to Southeastern Alaska. The iron and steel program is considered to be of special long-range importance to the Alaskan as well as the Pacific Coast economy.

Nonferrous Metals: This program provides for investigation of deposits of nonferrous metals throughout Alaska including, specifically, work on tin deposits on the Seward Peninsula and mercury or mercury-antimony deposits in the Kuskokwim River Basin. Work on a number of other base metal projects is now in progress. The work is a continuous program which has resulted in numerous publications presenting factual data on base metal deposits throughout Alaska.

Reconnaissance of Alaskan deposits for titanium, rare-earth, radioactive, and other strategic or valuable minerals or metals has been in progress for several years. The work consists principally of spot sampling of beach areas to obtain samples of heavy mineral concentrates for laboratory study. The re-

sults of the reconnaissance sampling of selected areas will be published in the near future.

A comparatively new program (for Alaska) authorizes an intensive search for the minerals of beryllium, particularly those occurring in nonpegmatitic deposits. Because tin is often associated with beryllium, the tin-bearing regions of Alaska (particularly the Seward Peninsula) are considered to be promising areas of investigation. Occurrences of other valuable minerals associated with beryllium, such as columbium, tantalum, cesium and rubidium, will also be noted and reported.

Nonmetallic Minerals: Because of the high cost of construction in Alaska, particularly at the extensive military and other governmental installations, the U.S. Department of the Interior in 1950 formulated a program for the development of Alaskan mineral raw materials in which both the USGS and the USBM took part. The objective of the investigations conducted by the Bureau as a part of this program was to determine the potentialities of local nonmetallic mineral deposits as sources of raw materials for the increased military, governmental and civilian construction program in areas accessible to the Alaska Railroad. The results of the initial investigation have been published (*Report of Investigations 4932*, 1953), but the work has continued on a reduced scale and supplemental reports will be issued from time to time.

Coal: Since about 1940, the Bureau has conducted drilling and other sampling investigations to determine the reserves and character of the extensive Alaskan coal deposits. Much of the work has been done in the Matanuska coalfield where the development of reserves was necessary to assure an adequate and steady supply of coal to provide power for the important defense installations and the rapidly growing civilian requirements in the Anchorage area. For the same reason, a preliminary examination of the strip coal potential of the Beluga coalfield has been conducted.

Because of growing interest in the possibility of exporting Alaskan coals, the program may be extended to include the investigation of deposits in other parts of the State—particularly those close to waterborne transportation facilities.

Petroleum: The Bureau collaborated with the Department of the Navy and the USGS in solving problems that arose in exploring Naval Petroleum Reserve No. 4 in the Arctic Slope. As a result of that work, the Bureau's Petroleum Research Center at Laramie, Wyo., prepared a publication (*Report of Investigations 5642*) on oil recovery and formation damage in permafrost and the Petroleum Research Laboratory at San Francisco prepared another report on drilling muds in relation to well productivity in the Umiat field (*Report of Investigations 5706*).

LABORATORY SERVICES

Testing and Analysis: Facilities maintained at the Juneau station include chemical, petrographic, ore dressing, and sample preparation laboratories. The sample preparation laboratory receives about 2000 samples from Bureau of Mines field projects and from selected ore deposits.

Analyses for all of the common metals and many of the rare elements are performed in the chemical laboratories. From 5000 to 7000 determinations per year are necessary to supply the analytical data required for field and laboratory investigations of ores and ore minerals.

All ores from mineral deposits investigated by the USBM or other officially authorized projects are subjected to laboratory tests to permit evaluation of their amenability to standard ore dressing procedures. Ores which do not respond to standard beneficiation procedures are recommended to specialized Bureau research centers and laboratories for long-range research provided they represent "type" ores that seem to occur in substantial quantities, have "strategic" value or are from government-financed operations.

For several years USBM personnel have been engaged in obtaining samples of heavy mineral concentrates from placer operations and beach sand deposits throughout Alaska. These samples are petrographically and spectrographically analyzed for valuable minerals other than gold.

Sampling and Inspection of Coal: Settlement of coal purchase for military and other Federal Government installations is based on USBM coal analyses and sampling procedures. In addition to the prompt analyses of samples representing coal delivered to the military bases, laboratory personnel also collect coal samples at the mine face, tipple or preparation plant for the purpose of determining purchase specifications.

Analyses of Crude Oil: Samples of crude oil from Alaska are included in the program of analyses of crude oils from important fields throughout the world conducted by the Bureau's petroleum research centers at Laramie, Wyo., and Bartlesville, Okla.

ECONOMIC STUDIES

Activities under this function are principally concerned with 1) the collection and dissemination mineral production, consumption, accident and employment statistics; 2) the compilation and publication of general data of special interest to the mineral industry, particularly feasibility and mining methods and cost studies; and 3) studies of the Alaskan mineral economy and its trends. As a part of the Bureau's nationwide function of collecting and disseminating statistics of the mineral industry, the Juneau office collects, records and prepares for publication the statistics of the Alaskan mineral industry. This work involves periodic visits to mining operations throughout the State, and the mailing, tabulation and cross-indexing of the large number of questionnaires required to cover all phases of the mineral industry. The annual Alaska chapter in the Bureau of Mines *Mineral Yearbook* (Volume III) is prepared for these data, as are the *Area Reports*.

Coincidental with the collection of mineral statistics, considerable information of general interest and value to the mining industry is accumulated. These data are organized and are published from time to time. An example of these "type" publications is the *Information Circular 7844* on "Southeastern Alaska's Mineral Industry". Some of these studies are conducted in cooperation with the University of Alaska, the State of Alaska or both. The University recently cooperated in the gathering and compiling of data on "Placer Mining in Alaska," which has been published as *Information Circular 7926*. An economic study projecting the future of the mineral industry has also been completed; it is now awaiting publication. Plans for the future include such other special studies as may be of benefit to the new State of the Nation.

Division of Mines and Minerals, State of Alaska

Supplementing the activities of the U.S. Bureau of Mines is the Division of Mines and Minerals of the State of Alaska, directed by James A. Williams. Headquartered in Juneau, the "DM&M" is one of the three major divisions of the Alaska Department of Natural Resources. The DM&M, in turn, is subdivided into five branches of primary interest: Administration, Mining, Metallurgy, Petroleum, and Geology.

The present Division of Mines and Minerals is the culmination of a series of Federal and Territorial acts which began in 1903 when an Act of Congress extended to Alaska the provisions of the "Act for the Protection of the Lives of Miners in the Territories." In 1911, President Taft appointed the first Alaska mine inspector who served under the direction of the USBM. Two years later, the Territorial Legislature established the office of Territorial Mine Inspector whose duty it was to enforce the mining regulations and to provide for the health and safety of miners. As before, the Mine Inspector was under the supervision of the USBM, an arrangement which existed until 1931 except during the years 1917 to 1923.

In 1935, the forerunner of the present organization was established when the Legislature created the Department of Mines and the Office of Commissioner of Mines. Upon the granting of statehood to Alaska in 1959, the new State Legislature authorized the formation of the Department of Natural Resources and renamed the Department of Mines to the Division of Mines and Minerals.

DIVISION RESPONSIBILITIES

The duties of the DM&M are, as in other states, quite varied. The principal responsibilities, outlined in the 1960 Annual Report of the Division of Mines and Minerals, are:

1) Inventory all mineral deposits of Alaska giving location, bibliography and current ownership.
2) Record activities of mining and mineral industries, their productivity, and the methods employed in processing minerals.
3) Provide the public with correct information pertaining to the geology and mineralogy of Alaska, its mineral resources, mining activities and usefulness of its minerals.
4) Administer the laws pertaining to mining, mine safety, oil well drilling, and conservation of oil and gas.
5) Stimulate mineral discoveries by assisting prospectors and others with professional advice, identification and analyses of minerals and ores, examination of deposits, prospecting equipment rental, and geophysical surveys.
6) Promote the development and utilization of mineral deposits by assisting companies seeking new mineral sources and mining investment opportunities.

It is also the task of the DM&M to advocate whatever necessary changes are desirable in the laws of Alaska to foster increased mineral development, to protect investors from fraudulent promotions, and to cooperate with other State and Federal agencies in matters concerning the Alaskan mineral industry.

Because the state is so large and much of it still relatively unknown, the interchange of facts and ideas with other State and Government departments is of great importance. The Division and the USBM have a formal agreement for the mutual exchange of information, thus eliminating duplication of work. Similarly, the Division and the USGS cooperate closely in matters of mutual interest. Among the other agencies with which DM&M cooperates are the U.S. Bureau of Land Management and the U.S. Forest Service. Both organizations have supplied the Division with important information on the status of mineral lands and claims and have received, in turn, mining claim ownership information and reports on mineral deposits and mineral areas.

RECENT DIVISION ACTIVITIES

Operating under the duties decreed to the DM&M, the Division has undertaken a variety of projects, two of which are of particular interest. One of these is a comprehensive analysis of current costs of mining and marketing mineral products in the state. A primary purpose of this study is to provide accurate, authentic information so that the mining industry can make a ready comparison of development and exploitation costs in Alaska with those incurred in other areas of the world outside of the contiguous 48 states.

If the economics of mining in Alaska are of vital concern, marketing of mineral production is no less so. This aspect of the Alaskan mining industry has been investigated by various governmental bodies and private companies, and during the past few years, the surging economy of Japan has been a center of their attention. In 1960 the State initiated an exchange of information pertaining to demand, consumption and marketing of minerals and fuels in the Japanese economy with the Japanese Ministry of International Trade and Industry. During the past summer, Phil R. Holdsworth, Commissioner of Natural Resources, went to Japan to investigate the relationship between their needs and Alaskan resources. Iron, copper, lead, zinc, nickel and antimony were of particular concern to the Japanese, and they voiced their continuing interest in the formation of joint ventures or domestic corporations to mine these metals.

With the cooperation of the USBM, USGS and other Federal agencies, the Division is constantly working to fulfill its primary mission—aiding in the development of Alaska's economic mineral deposits. As this industry grows larger, much of the credit will rightfully belong to the members of the Division of Mines and Minerals.

UNIVERSITY OF ALASKA

by EARL H. BEISTLINE

Dean
College of Earth Science and Mineral Industry
University of Alaska

Vast, virtually undeveloped lands in mineralized areas of Alaska offer rich opportunities and challenges for persons in the mineral industries. Mineral Industry education has been an important part of the University of Alaska educational program since the institution opened on September 18, 1922, as the Alaska Agricultural College and School of Mines. The institution gained University status in 1935. It is located in almost the geographical center of Alaska, near Fairbanks, on a promontory which commands a panoramic view of the Tanana Valley and the main Alaska Range, including Mt. McKinley, the highest (20,300 ft) peak in North America.

The University's setting and the fact that it was born in the immediate aftermath of Gold Rush days in an atmosphere of pioneering spirit has given an air of inspiration for academic and research endeavors and achievements which is typified on the University Seal: Mt. McKinley rising full height, and at its base the motto *Ad Summum*, meaning "to the heights."

On July 1, 1961 under the guidance of Dr. William R. Wood, President of the University of Alaska, the academic units of the growing University were reorganized, and the School of Mines became known as the College of Earth Science and Mineral Industry. This College, one of six within the University, is headed by a Dean, and at the present time has two departments. These are the Department of Geology and the Department of Mining and Metallurgy, both of which had their beginning in curricula in geology, mining and metallurgy, first developed by Dr. Ernest N. Patty as a member of the original faculty and now President Emeritus of the University of Alaska.

The Department of Geology, headed by Dr. Troy L. Péwé, has a staff of four full-time and three part-time faculty members. Students enrolled in the Geology Department may follow courses of study leading to a B.S. in Geology or Geological Engineering and a M.S. in Geology. This department is housed in the Brooks Memorial Mines Building, a four-story concrete structure named in memory of the late Alfred Hulse Brooks, a distinguished geologist who pioneered U.S. Geological Survey work in Alaska for nearly 25 years after the turn of the century. In addition to the University's classroom and laboratory instruction, Alaska has natural geological laboratories of glaciers, permafrost, fuel and mineral deposits, mountains and volcanoes that offer excellent fields for instruction to undergraduate students as well as reseach projects for graduate students.

The Department of Mining and Metallurgy, headed by Dr. Donald J. Cook, has a staff of three members and is also housed in the Brooks Building. Students enrolled in this department may follow courses of study leading to a B.S. in Mining Engineering, Mineral Beneficiation or Metallurgical Engineering and a new graduate program, leading to a M.S. in Mineral Industries Management, has been recommended by the University Academic Council. All engineering graduates in the College also may earn the professional degree, Engineer of Mines. Alaskan operations in gold, coal and other mining, including gas and oil production and exploration activities, give additional advantages to the student taking academic instruction in the classroom and laboratory.

In cooperation with the University's Division of Statewide Service, the College participates in a program of mining extension courses that are given throughout the vast State during the academic year. Approximately 700 persons interested in the mineral industries enroll in the courses each year. Led by veteran teacher, Professor Leo Mark Anthony, two instructors travel to various communities and conduct the non-credit courses which are basically designed to aid the practical prospector in his search for ore deposits.

Also housed in the Brooks Memorial Mines Building on campus are units of the U.S. Geological Survey, U.S. Bureau of Mines, and the State Division of Mines & Minerals. This arrangement, leading to close association and cooperation and sharing of some facilities, tends to give harmony and efficiency to the work of all.

FUTURE OF ALASKAN MINERAL INDUSTRY

by RICHARD J. LUND

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Any attempt to forecast the future of the mineral industry in an area involving the size and unknowns of Alaska is to invite controversy. In forecasting future potentials for Alaskan mineral output (tonnage, value, employment, etc.) it was thus decided that these should be based solely on feasible developments from *known* occurrences of minerals. In other words, it was decided not to attempt to predict what *might* be found and developed in the future, based on elaborate probability formulas tied in with inferences and assumptions concerning broad geologic features and concepts.

Battelle Memorial Institute recently spent 18 months in the study of economic needs for improved transportation facilities between Alaska and the southern 48 states. This study, done at the request of the Alaska International Rail & Highway Commission, has recently been printed by the U.S. Government as a part of the Commission's report to Congress.* Although the primary purpose of the report is not solely an evaluation of the mineral potential of Alaska, and should not be viewed in the same light as such a report, the studies have given this author an insight into what developments may occur in Alaska during the next 20 years. Because metals and industrial minerals are of primary concern in this issue of MINING ENGINEERING, the oil and gas discoveries on the Kenai Peninsula, south of Anchorage, and elsewhere in Alaska are only mentioned briefly.

Output of gold and copper from fabulous deposits along the Yukon and at Kennecott in the early decades of this century gave Alaska its reputation as a "vast storehouse of mineral wealth" awaiting to be tapped. This impression still prevails in the minds of the general public. However, a careful review of the size and grade of known Alaskan mineral occurrences (other than oil and gas) when compared with deposits being exploited elsewhere in the world indicates clearly that, except for a few well known possibilities, major future mineral developments will have to come from new discoveries in the many geologically favorable areas or from favorable results in further exploration of many hundreds of other possibilities now known in the State.

The best known potential mineral operations for development in the next 20 years appear to be the following (numbers refer to locations shown on the accompanying map):

1) A mill near Ketchikan to beneficiate iron ore from numerous small deposits in the general vicinity of Kasaan Peninsula in the southern part of Southeastern Alaska.

2) A large mill to beneficiate, and possibly a plant to smelt the huge alluvial titaniferous iron ores near Klukwan, about 20 miles north of Haines in the north end of Southeastern Alaska.

3) A smaller mill to beneficiate, and possibly a plant to smelt the large titaniferous iron ore lode deposit on deep tidewater at Snettisham, about 35 miles southeast of Juneau.

4) A mine, mill and possibly a smelter to produce copper concentrate or blister from the large Ruby Creek copper deposit near Kobuk in the northwestern part of Alaska.

5) A mine and mill to produce copper concentrate from the low-grade Sumdum copper deposit on deep tidewater about 40 miles southeast of Juneau.

6) Perhaps two new mercury mine, mill and retorting operations in the Kuskokwim River area—possibly at White Mountain and DeCoursey Mountain.

7) Production of limestone to produce cement at plant near Sutton, about 75 miles northeast of Anchorage.

8) Production of limestone on Dall Island, about 70 miles southwest of Ketchikan for shipment to the Pacific Northwest.

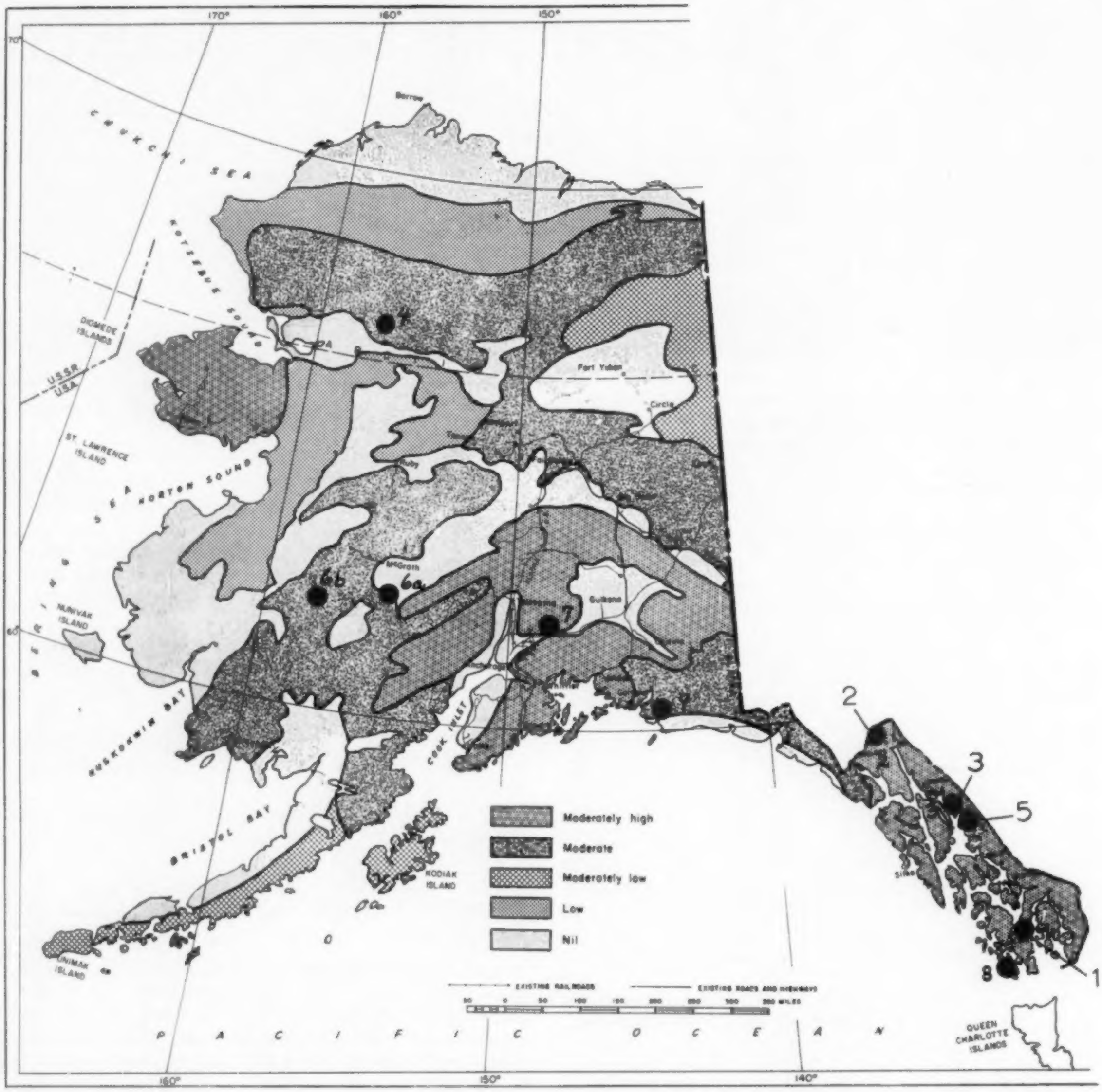
9) Production of coking coal from a new mine in the Bering River field near the Gulf of Alaska about 50 miles east of Cordova.

Development of these promising prospects within the next 20 years has a reasonable potential of yielding a total annual output of some 5,700,000 short tons of minerals (ores, concentrates, metal and coal) having a value of some $77 million, and employing about 2500 persons.

Unless its price is boosted substantially, gold output will contract severely in the next few years. Continued coal output from the Matanuska and Nenana fields along the Rail Belt may also dwindle as the large reserves of natural gas from the Kenai are exploited and piped to main consuming centers (civilian and government) in the Anchorage and possibly Fairbanks areas. Several barite deposits in Southeastern Alaska may warrant reexamination as a possible source of additives for drilling mud if oil and gas drilling in Alaska continues to expand.

None of the nine promising potentials listed above can be classed as definitely assured, with the possible exception of the Sutton limestone to supply a definitely planned cement plant. Thus, any *assured* major future mineral developments will be largely dependent upon market, shipping and technological conditions as well as on finding deposits that are bigger and/or higher grade than those now known. Some large mining companies that have been actively exploring Alaska in the recent past are quite optimistic and consider the area good "hunting ground" for metal discoveries. There is still the strong, general hope of making one or more new

* Transport Requirements for the Growth of Northwest North America. Report to Congress by the Alaska International Rail & Highway Commission; House Document 176, vol. 2; 87th Congress, 1st Session, Gov. Printing Office, Washington, September 1961.



Comparative lode metal potential of Alaska, and most promising potentials for new future mineral developments from known occurrences.

1. Kasaan Area—iron ore
2. Klukwan Fan—iron ore
3. Snettisham—iron ore
4. Ruby Creek (Kobuk)—copper
5. Sumdum—copper

6a. White Mt.—mercury
6b. DeCoursey Mt.—mercury
7. Sutton—limestone
8. Dall Island—limestone
9. Bering River—coking coal

fabulous finds comparable with the Kennecott deposit in Alaska or the United Keno Hill just east in Yukon Territory.

But in this metal "hunting game", again, Alaska must compete for exploration dollars with other areas throughout the world. Unfortunately, mountainous terrain, short seasons, fickle weather, scarcity of lakes for landing airplanes, and remoteness combine to make prospecting in much of the region more costly than in many other geologically attractive areas, such as the Precambrian Shield of Canada.

However, recent social and political developments in many foreign areas have greatly augmented the risk factor in developing and conducting enterprises abroad. This may well result in kindling more lively interest on the part of mining companies to expand exploration efforts in Alaska, where, in spite of weather difficulties, the *business* climate is highly attractive. High labor and material costs are an obstacle, but improved transportation, with plans under way for more pioneering and access roads, should help some in reducing these.

METALLIC MINERAL POTENTIAL

Iron Ore: All promising occurrences are in Southeastern Alaska, on or close to tidewater. A buried deposit (Kemuk Mountain) northeast of Dillingham hasn't been described, but is believed similar to Klukwan and Port Snettisham lodes.

Replacement-type Deposits: Numerous small iron ore deposits, carrying small amounts of copper, occur in the southern part of Southeastern Alaska in the general vicinity of Kasaan Peninsula. These

are generally similar to deposits now under production on Vancouver Island, and may total 10 to 25 million tons of ore running 40% to 50% Fe, as estimated by USGS. They could support one mill treating ores from several deposits, with output of perhaps 600,000 tons concentrates annually. Mt. Andrew Mining Co. (Utah Construction) is most active there.

Klukwan Alluvial Fan: This deposit comprises a minimum of 500 million tons of alluvial material derived from the Klukwan lode deposit in the mountain to east, about 20 miles northwest of Haines. The material averages about 10% to 12% magnetic iron and 2% TiO_2. It could be mined very cheaply (might be dredged) and is easily concentrated to about 58% Fe while holding TiO_2 to 2%. An operation there might produce two million tons of concentrate annually or perhaps one million tons of pig iron or semi-steel by pretreatment-electric smelting, if huge cheap power resources at Yukon-Taiya project near Skagway were developed by the Government. Possible markets are Japan or the West Coast. Columbia Mining Division of U. S. Steel owns claims and has made extensive tests on 5000-ton shipments.

Klukwan Lode: Located east of the Klukwan fan, this contains larger reserves—probably over one billion tons—of titaniferous magnetite running 15% to 20% Fe and about 4% TiO_2. Because of easier mining, the fan deposit would probably be exploited first. Columbia Mining Division of U. S. Steel controls virtually all claims.

Port Snettisham Lode: Located on the Inland Passage about 35 miles southeast of Juneau, this is a huge titaniferous magnetite deposit similar to Klukwan, carrying similar amounts of Fe and TiO_2. The ore can be concentrated to 65% Fe while the TiO_2 content is lowered to 3% or slightly less. This deposit probably totals close to 500 million tons of ore. Modest size attractive hydropower nearby could supply power for mining and milling perhaps 325,000 tons of concentrates annually. The ore could possibly be smelted to pig iron with pretreatment-electric furnace process. W. S. Pekorich of Juneau and W. S. Moore of Duluth control this deposit.

Union Bay: A huge deposit similar in origin and grade to the Klukwan lode occurs on the northwest side of Cleveland Peninsula, about 35 miles northwest of Ketchikan. Exploitation of the Klukwan fan would probably take precedence over Union Bay. U. S. Steel and others have joint interests.

Copper: The one major potential (Ruby Creek) is handicapped by its remote location. The Prince William Sound area probably merits reexamination. Most work has been done on the following:

Ruby Creek: This prospect, near Kobuk in northwestern Alaska, is a large copper deposit in reef limestone. It has been extensively drilled for five seasons, indicating probably over 100 million tons of over 1.2% copper. Earlier drilling revealed mainly chalcopyrite mineralization, but later work shows much bornite that has probably boosted grade above the figure mentioned. It might assume an open pit operation at 10,000 tpd with 1.5% ore, yielding around 160,000 tons concentrate annually or possibly 50,000 tons of blister if smelted there. The transportation problem to coast and the long ocean haul favors smelting locally if possible. It leads all other Alaskan metal prospects by far in amount of development work done, and has good chance of making a major producer. Bear Creek Mining Co. (Kennecott) controls the property.

Sumdum Deposit: Located on the Inside Passage about 50 miles southeast of Juneau, this massive sulfide deposit of pyrite and chalcopyrite comprises up to 30 million tons that runs about 1.25% copper. It would have to be underground mining in major part, since it extends beneath a glacier at elevation of approximately 3000 ft. It is presently considered too low grade to make ore at this time by Moneta Porcupine Co., who did drilling work in 1959 on behalf of several others in syndicate.

Orange Hill: This is a huge low-grade disseminated copper deposit about 40 miles north of Kennecott, estimated at 200 million tons running 0.4% copper and very low values of molybdenum, gold and silver.

Lead-Zinc-Silver: Past lead-zinc-silver output of Alaska has been minor to nil, and prospects for the future from known occurrences are not promising. Best known deposits are:

Mt. Eielson: Situated near Mt. McKinley in south-central Alaska, it contains an estimated 200,000 tons carrying about 5% zinc and from 0.2% to 0.3% copper.

Groundhog Basin: These deposits on mainland east of Wrangell in Southeastern Alaska, are largest known in Alaska. USGS estimates 550,000 tons running 8% zinc and 1.5% lead plus 500,000 tons lower grade averaging 2.5% zinc and 1% lead.

Gold: Output of gold has been dropping slowly, and will really take a nose dive when major dredge operations near Fairbanks and Nome are terminated, (scheduled for 1962 or 1963 by U. S. Smelting Refining and Mining Co.). Gold-bearing gravels in the Fairbanks area are largely depleted, but marginal deposits remain near Nome and many other localities that could be mined at a higher gold price.

Mercury: The only presently operating underground metal mine in Alaska—the Red Devil (see page 1337)—has had a steady production record of several thousand flasks annually since the plant was rebuilt in 1956 following a fire that interrupted early smaller operations. Ore is rich—around 40 lbs per ton—but known reserves have always been small, and costs are high. Even with their rich ore (mercury mines in the southern 48 states average less than 10 lbs per ton), present mercury prices appear to be "squeezing" this operation.

Many other mercury occurrences are known in the Kuskokwim River area, perhaps the most promising of which are at DeCoursey Mountain and White Mountain, (see map). Development of these will require a stronger market and higher mercury prices. The Japanese have shown interest in the future operation of the Red Devil as well as other mercury properties.

Antimony: Antimony deposits are quite widespread in Alaska, especially in the southwestern part where it generally occurs as a somewhat undesirable ingredient with the mercury ores in the Kuskokwim area—frequently in amounts about equal to the mercury. The better known past operations are in the Fairbanks district which produced a total of some 2500 tons of stibnite in the early part of the century, and the Stampede mine north of Mt. McKinley which has produced some 2600 tons of antimony since 1936. Small operations may resume periodically, and antimony might be recovered from the Red Devil and additional mercury operations in the future.

Platinum: Continued operation of the Goodnews Bay placer platinum dredging operation, located just north of Cape Newenham between Bristol and Kuskowim Bays, will continue for another decade or so, when reserves at the 90-ft depth now being dredged are expected to be depleted. Additional reserves at about twice that depth cannot be mined economically at present platinum prices.

Chromite: Small quantities of chromite have been mined at Red Mountain and Claim Point near the tip of the Kenai Peninsula south of Anchorage for sale to the government at premium prices. The USGS estimates reserves at 30,000 tons containing over 40% Cr_2O_3, and 175,000 tons running about 20%. Such tonnages are insignificant in terms of U.S. chromite requirements, but further exploration of numerous areas of ultrabasic igneous rocks in Alaska could uncover the larger and higher grade deposits that would be needed for any substantial chrome mining operation.

Tin: The tin deposits on Seward Peninsula represent probably the best known tin occurrences of North America, but known reserves are limited in size. Greatest interest has centered in the Lost River tin mine, operated with Government funds from 1951-55, during which 687 tons of concentrates averaging 52% of tin were produced. Costs amounted to $1.33 per lb of tin recovered. In the late 1940's, prior to the mining operations, the USGS estimated reserves at 5500 to 6500 tons of contained tin. Placer tin deposits on Cape Creek on Seward Peninsula might yield about 2000 tons of tin from one million cu yd of gravel.

All in all, from known occurrences the Seward Peninsula area might produce approximately 500 tons of tin per year for ten years or more at prices above $1.35 per lb. Once mining is resumed and continued, there should be good chances of extending the reserves as estimated some time ago. Continuation of the recent rise in the price of tin might justify consideration of operation of these properties and active exploration for new deposits in that area and in numerous reported favorable belts north and south of the Yukon River in central Alaska.

Tungsten: Alaska's known potentials from small deposits in the Hyder and Fairbanks districts (small past production at premium prices) and as a by-product from possible operation of the Lost River tin mine are not impressive.

Nickel: There has been no known production of nickel from Alaska, but much effort has gone into exploration of deposits in Southeastern Alaska—especially at Bohemia Basin on Yakobi Island, about 100 miles southwest of Juneau. This has been repeatedly examined and drilled since its discovery during World War II. As estimated by the USGS, reserves there amount to the substantial figure of 20 million tons, but averaging only 0.32% of nickel and 0.20% copper. This grade is far below the combined 3% representative of the Sudbury and Thompson deposits. Other deposits to the south at Funter Bay, Mirror Harbor and Snipe Bay are somewhat higher grade but are much smaller. Due west of Juneau, the Brady Glacier overlies a copper-nickel prospect which has interested Newmont Mining Co.

Molybdenum: A deposit of 10,000 to 20,000 tons averaging 0.9% molybdenum occurs at Shakan on Kosciusko Island in Southeastern Alaska, and larger deposits of low-grade material are known at Muir Inlet northwest of Juneau and on Baker Island west of Ketchikan. These run millions of tons of material that average about 0.06%. The large Orange Hill low-grade copper deposit, already mentioned under "Copper," carries 0.03% molybdenum.

Other Metals: *Bismuth* occurrences are known, but are of minor importance and probably wouldn't yield significant amounts of metal.

Uranium was mined from the southern part of Prince of Wales Island (Bokan Mountain), but production so far has been only 17,000 tons of ore running 1% U_3O_8. Chances of finding and developing any substantial uranium operation in Alaska appear unlikely in the face of excess supplies and reserves in the southern 48 states and Canada.

With respect to pegmatite-bearing metals such as *beryllium, lithium, columbium* and *tantalum*, experienced Alaskan geologists have commented that pegmatites are relatively scarce in Alaska, and those that are found are lean or lacking in these metallics.

INDUSTRIAL MINERALS POTENTIAL

Limestone: Deposits of large size and high purity are found on many of the islands in southeastern Alaska. Hundreds of millions of tons are available. The rock meets specifications for a variety of uses—cement and lime, chemicals, flux stone, calcium carbide, etc. It is reasonable to assume at least one sizable quarrying operation—perhaps on Dall Island where Ideal Cement carried on development work in 1960—for shipment to the Pacific Northwest. Several of such operations might well develop in the next decade or two.

A limestone operation at Sutton, about 50 miles northeast of Anchorage, is planned by Permanente Cement Co. to supply rock for a 500,000 bbl-per-year cement plant. This is more than adequate to supply Alaska's present and anticipated cement needs for some time.

Clay and shale: Deposits are known in the Rail Belt, stretching between Seward, Anchorage and Fairbanks, that are adequate to supply small local construction needs, including expandable materials for light weight aggregate.

Sand and Gravel: Deposits are relatively abundant in Alaska—at least near the population centers of Anchorage and Fairbanks. Heavy military-supported construction pushed total value of output in the state ($5.5 million) up close to that of coal and gold in recent years. Future output at comparable levels to supply local road and building construction programs may be anticipated.

Phosphate rock: Occurrences in comparatively thin beds along the Arctic Slope of northern Alaska were found during the geologic investigations of Naval Petroleum Reserve No. 4. Although poorly known and described, their isolated location precludes their development for many years, with reserves elsewhere in the U.S. and Free World so plentiful.

Barite: A few small occurrences in Southeastern Alaska might merit restudy as a source of drilling mud additive if Alaska's oil and gas development continues to grow.

COAL

Estimates by the USGS based on very limited exploration indicate about 95 billion tons of reserves in Alaska, 80 billion tons of which are along the Arctic Slope. Of this 80 billion tons, 25% is bituminous grade and 75% is subbituminous or lignite.

Most past production has come from the Nenana (subbituminous) and Matanuska (bituminous) fields near the north and south ends of the Rail Belt, respectively. Descriptions of mining operations in these fields are found on pages 1330 and 1333.

Much interest was shown in the late 1950's in the possibility of developing a mine of coking grade coal in the Bering River field (No. 9 on map) for export to Japan. Sizable samples were mined for testing purposes and these showed good coking characteristics. However, the coal there is highly folded, faulted and crushed, and much development work remains to be done to prove up the necessary tonnage of satisfactory grade that is minable at costs required to meet market demands. The Jewell Ridge Coal Co. has held up further activities on this during the past two seasons. If such development is done, with favorable results, a one million ton-per-year operation could result.

Opportunities for mining steam coal for export purposes appear limited. High labor, material and transportation costs make reaching competitive prices f.o.b. Alaska shipping points difficult, but shipments to the Orient are considered by many people to be within the realm of possibilities.

As for future local consumption, the substantial oil and gas developments on the Kenai Peninsula foretell probable invasion of past coal markets for civilian and military heating and power—first in the Anchorage area to which a gas pipeline has already been completed, and perhaps before long to the Fairbanks area. Output of fuel oil from the planned oil refinery on the Kenai will intensify this competition. The future of Alaska coal mining, except possibly for coking coal, is seriously threatened.

OIL AND GAS

Although aimed at the mining and quarrying industry, this discussion of Alaska's future mineral potential must include at least a brief reference to the major oil and gas investigations and developments of Alaska. Activities in the past few years have uncovered significant oil production and probably major natural gas resources on the Kenai Peninsula. Latest reports indicate a total of over 40 producing oil wells with a daily output of more than 20,000 bbl being transported through a pipeline to a terminal on Cook Inlet for tanker shipment to the West Coast. Standard Oil Co. of California has announced plans to construct a 20,000 bbl-per-day refinery on the Kenai to supply Alaska's growing local needs.

Known natural gas reserves are large—far more than needed to supply all of Alaska's local domestic, commercial and military requirements. A pipeline to Anchorage has been completed and will supply domestic and commercial users there this winter. Gas could fuel electric plants for sizable output that might well compete in price with potential hydroelectric power in the area. It is too remote to pipe to major consuming centers in the Pacific Northwest, but serious study is being given to the possibility of liquefying the gas and shipping it to important consuming centers on the Pacific periphery, especially Japan.

FUTURE OUTLOOK

This brief analysis of the *better known* prospects for mineral development confirms the broad generalization that the future of Alaskan mining is difficult to predict. It depends in part on the discovery of deposits of larger size and/or higher grade than those known to exist there now, and in part on the development of transportation, technological advances, and market conditions. With the few exceptions noted in the summary, the known occurrences are submarginal—especially in view of the higher costs of developing and operating mines, as outlined in Alvin Kaufman's article on page 1343. But large numbers of mineral occurrences are widely scattered through the State, as evidenced in the series of four excellent resource maps issued by the USGS in 1960.* These also show quadrangle boundaries and list references of government publications that describe the occurrences of specific metals in each quadrangle. However, no indication is given as to relative size; the only lead in this respect is identification of those deposits from which some production has been recorded in the past.

These maps should be very helpful to companies undertaking exploration work in Alaska. Further investigation of many of these may lead to development of substantial producers.

But more important is the reconnaissance of vast areas of virtually virgin prospective metal-bearing areas by modern exploration techniques. Badly needed to spur such activity are more pioneering roads to vast areas in the State. The present interconnected road system is confined solely to the southeastern portion of what might be termed "Peninsular Alaska," which excludes the Panhandle. Roads giving land access to the northern slope of the Alaska Range west of the Rail Belt and to the vast areas of the Brooks Range in northern Alaska would greatly assist exploration, and should be given top priority in Alaska's future road program.

Small air fields are scattered widely throughout the State, but more of these with improved weather reports and forecasts have been mentioned by mining companies as important needs in more intensified exploration work.

Development of some of the vast hydropower potentials scattered through the State would assure relatively cheap power for new mining and possibly smelting and refining operations. Gas and oil resources already proved on the Kenai and Arctic Slope will also help, and chances of finding more elsewhere in the state are fair to good.

Aerial geophysical reconnaissance of the type being undertaken by the Geological Survey of Canada over its vast unexplored northlands, would be of great assistance, but this general type of work has not yet been initiated in Alaska.

As a broad, general guide to future transportation planning, a map was prepared showing comparative lode-metal potentials of the entire area covered in the study for the Alaska International Rail and Highway Commission. The Alaskan portion of this is shown on the accompanying map. In its preparation, various maps on physiography, geology and metal occurrences (those previously footnoted) were of major help, and it was critically reviewed by a number of government and industry geologists. It should be emphasized that the classification of areas is based only on general knowledge and judgment and serves only as a broad indication of the relative promise of finding metals in the various areas.

* U.S.G.S., Mineral Investigation Resource Maps, edited by E. H. Cobb, 1960.
a) Chromite, Cobalt, Nickel and Platinum Occurrences in Alaska, Map MR-8;
b) Copper, Lead, and Zinc Occurrences in Alaska, Map MR-9;
c) Molybdenum, Tin, and Tungsten Occurrences in Alaska, Map MR-10;
d) Antimony, Bismuth, and Mercury Occurrences in Alaska, Map MR-11.

AN ALASKAN'S VIEWPOINT

by JAMES A. WILLIAMS

Director
State Division of Mines and Minerals
Juneau

Recent significant base metal discoveries in Alaska have been limited only by the small amount of careful scientific exploration done thus far. In an area as widely mineralized as this huge State, it is not reasonable to believe that all the major economic mineral deposits have been found. The chief period of mine development corresponds with the period of placer prospecting. The ore deposits found then were generally those that cropped out prominently or were associated with gold placers. Alaska occupies the same geological belt as the western states, but is more heavily covered with vegetation and alluvial material. With constantly improving methods of detecting hidden deposits, it follows that the rate at which more major deposits will be discovered depends on the rate at which favorable regions are covered by effective exploration methods. These methods have only begun in Alaska during the last few years, and have so far gained little momentum as compared to this activity in some of the western states and Canada. The rate will increase. Alaska is good ore-hunting country for the large sophisticated company with good financial backing.

Favorable areas are indicated in almost all sections of the State by the hundreds of early prospects. While it is true that the major portion of Alaska's geology has not yet been mapped at a scale which is most useful to prospectors, there are many USGS maps and bulletins available, and more are accumulating as recent work is completed. Other published and unpublished information is available in the files of the State Division of Mines and Minerals and the U.S. Bureau of Mines. The known mining districts have been well outlined.

The production of Alaska's presently known but idle mineral deposits, as well as the rate of exploration which will discover more, depends on marketing conditions and demand. The demand in the Pacific Northwest for metals, chiefly iron, is increasing steadily, but not at a sufficient rate that it alone is likely to influence early Alaskan production to a marked degree. Canada, of course, is completely self-sufficient in minerals. The real opportunity at present is in selling to the Pacific Rim countries, chiefly Japan. Japanese companies are extremely interested in acquiring iron, copper and nickel from Western North America. They have made large purchase agreements in British Columbia for copper and iron, and they hope to do the same in Alaska, for the shipping distance is shorter.

Last summer, the Japanese market possibilities caused the largest boom in British Columbian mining and exploration that the Province has seen in years. New records have been established there in the staking of mining claims and in the value of mineral production. A break-through into the Oriental market by Alaska will have the same results. This break-through is only a matter of time. Canadians have publicly expressed apprehension that Alaskan competition will reduce their advantage. Alaska has deposits similar to those in British Columbia which are now in production, and there is little doubt that some of these Alaskan orebodies will be "on stream" in a relatively short time.

One aspect often discussed is the apparent "remoteness" of many parts of Alaska, but remoteness is only relative to the incentive offered or the possibilities in view. The Kobuk area seemed too remote to most to consider a copper development project until Bear Creek Mining Co. started drilling there. An example that should ease the apprehension of remoteness is that of Texas Gulf Sulphur drilling a lead-zinc prospect on Baffin Island in Canada at a latitude 90 miles farther north than that of Point Barrow.

Alaska's climate is often pointed out as a deterrent. The Alaskan winters, while longer, are no colder than those in parts of other northern states, such as those at Butte, for example. Precipitation varies widely in different sections, but the snowfall in most of Alaska is less than that in the northern states. The petroleum industry is carrying out drilling and seismic operations without stop through the winters in some of the coldest parts of Alaska. The State's steadily growing year-around population is also noteworthy.

An important factor to consider is that unrest and nationalization in formerly advantageous foreign countries are increasing the interest in looking northward for new operations. Serious inquiries from U.S. iron companies regarding Alaska's iron deposits have shown a distinct increase lately.

Everyone points at Alaskan costs. On this item, let us quote from a paper presented at the Fifth Annual Alaskan AIME Conference by R.H.W. Chadwick, an eminent Bear Creek Mining Co. geologist who is well experienced in Alaskan operations. Speaking of logistics in Alaska, Mr. Chadwick said, "However, the clear lesson is that with air transport, copters and tracked vehicles, exploration can be easy. Furthermore, it need not be expensive, *provided*—and this cannot be emphasized too much—*provided* detailed plans are made a year ahead." On capital and operating costs, he stated that if the Kobuk property became a mine, the ore grade and cut-off grade "must be one-and-a-half times what would be profitable in the States." Considering the location of this property and the low grade of copper ores now in production in the other States, this is an encouraging cost factor.

In conclusion, it is apparent that Alaska's hardrock mining industry will move ahead. Only the precise rate of speed is unpredictable.

SME BULLETIN BOARD

Reports of Your Technical Society

SEASON'S GREETINGS FROM THE STAFF

TO ALL OF THE MEMBERS OF SME

UNITED ENGINEERING CENTER DEDICATED

pp. 1358—1359

NOTICE TO MEMBERS:

SME Board Meeting—Beginning at 9:30 a.m., Monday, February 19, an all-day meeting of the present and incoming members of the SME Board of Directors will be held in the Hartford Room of the Statler-Hilton Hotel.

AIME Annual Business Meeting—This meeting will be held Tuesday afternoon, February 20, in the Grand Ballroom of the Statler-Hilton Hotel, immediately following the All-Institute Session of the Annual Meeting.

ENGINEERING DEDICATION

Eric A. Walker, the principal speaker at the dedication ceremony, is pictured at the right. He is president of Pennsylvania State University and had a distinguished career in the fields of education and public service behind him before assuming that office in 1956. Below, the attentive audience listens to W. F. Thompson, who presided. Seated on the platform in addition to the speakers were many eminent guests including society presidents and those directly concerned with the construction of the new center.

Throughout the day there were colorful ceremonies to mark the historic occasion. Shown at the left: Mayor Robert F. Wagner presents the key to the city to W. F. Thompson, President of United Engineering Trustees. In accepting it, Thompson said the key would be kept on permanent display in the building. Below left: The 579th Air Force Band from Stewart Air Force Base which provided music at the flag raising and the beginning of the dedication program. Below: A noon-time gathering watches as the flag, a gift from the 600 staff members of the engineering societies, is raised.

Distinguished engineers and civic notables gathered on November 9 for the dedication of The United Engineering Center. Under a cold gray sky the portion of the U. N. Plaza directly in front of the Center was renamed Engineer's Plaza for the occasion as W. F. Thompson, President of United Engineering Trustees, placed the sign.

At 2:00 pm, when the dedication began, a standing ovation was accorded Herbert Hoover, Honorary Chairman of the ceremonies as he mounted the platform. In the course of his remarks he pointed out that engineers have two major responsibilities: to take the discoveries of science and turn them into new inventions to keep American productivity ahead of all the world and to see that we maintain the supply of trained scientists and engineers needed for our growing economy and national defense.

Both President Kennedy and Gov. Rockefeller sent representatives to convey their good wishes. Mayor Wagner personally extended his congratulatory message and presented the key to the city to Mr. Thompson who was presiding.

Highlighting the occasion was the presentation of the Hoover Medal for 1961 to Mervin J. Kelly, former Chairman of the Board of Bell Telephone Laboratories Inc., by Mr. Hoover himself. Mr. Kelly had been associated with Mr. Hoover both on the second Hoover Commission and on planning for the Center. The citation, read by Walker L. Cisler, Chairman of the Hoover Medal Board, states: "Engineer, scientist, distinguished leader in industrial and military research whose dedicated efforts and engineering skill have contributed to greatly improved communications; who has furthered the cause of engineering service to mankind through inspired leadership in the creation of a great United Engineering Center."

The occasion ended with talks by a student, representing the future engineer, and a university president talking of the present responsibility of engineers. William L. Hallerberg, metallurgical student at the Missouri School of Mines and Metallurgy, acknowledged his generation's debt to those who have forged the tools which they in turn will use to surpass the accomplishments of the present.

Eric A. Walker, President of Pennsylvania State University, stressed the moral responsibility of the engineer. By transforming the discoveries of science into technol-

CENTER HAS CEREMONY

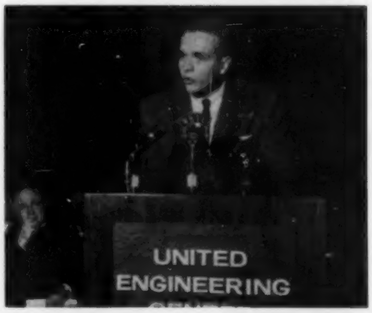
ogy, the engineer has contributed significantly to our health, wealth and material well-being and, in the process, has profoundly altered our physical, social and spiritual environment. The change has been so rapid that we have failed to replace the values that technology is rendering obsolete with values that can give real meaning to our society. Because the engineer transforms knowledge (which is morally neutral) into action, he has a moral responsibility to the community which is summed up in the definition "engineering is the profession in which knowledge . . . is applied with judgment . . . for the progressive well-being of mankind." This involves value judgments and a moral responsibility for the direction taken by our civilization.

With the pronouncement of the benediction the ceremony ended, and thus more than a decade of planning and effort had been brought to a close and the engineering societies had achieved their dream of a new home. It was the more significant because it represented the efforts of industry and the individual members of the societies to raise the necessary funds.

AIME, one of the Founder Societies, was given a quota of $500,000 as its contribution to the building. With Joseph L. Gillson as the directing head of the Member Gifts Committee (later succeeded by Lloyd Elkins), Edward H. Robie was selected as secretary and took over in April 1958. Since early 1959 Mrs. Winifred D. Gifford served as assistant to Mr. Robie. Under their able leadership the campaign was considered terminated on Sept. 1, 1961 with a total of $511,004 pledged, or 102.2% of its quota. Efforts on the Local Section level made this possible. Special commendation is given to the 27 Sections contributing more than 100%: Oregon, New York Petroleum, Uranium, Pennsylvania Anthracite, Hugoton, Utah, Minnesota, Ohio Valley, Tri-State, Philadelphia, Montana, Florida, Arizona, Lehigh Valley, Gulf Coast, San Francisco Carlsbad Potash, Panhandle, Hudson-Mohawk, St. Louis, Los Angeles Basin, Niagara Frontier, Pittsburgh, East Texas, Adirondack, Black Hills and Fort Worth.

Six Sections raised 90% or more of their quotas: New York, East Tennessee, Southern California, Lou-Ark, Boston and Spindle-top.

By individual efforts such as these, the dream became a reality, and in this sense each of you played a part in the dedication.



William L. Hallerberg, the student speaker, caught during an earnest moment of his address to the distinguished audience which included His Eminence, Francis Cardinal Spellman, seated to the left of the podium. In the picture below, AIME President McNaughton poses with several of his illustrious predecessors including the Institute's notable elder statesman Herbert Hoover. They are from left to right: Andrew Fletcher (1953), Herbert Hoover (1920), Michael L. Haider (1952) and Ronald R. McNaughton (1961).

A future engineer, William L. Hallerberg, senior student at the Missouri School of Mines and Metallurgy, pays his respects to a famous engineer of another generation, Herbert Hoover. Pictured below: John T. Carroll, representing the Manhattan Borough President, places the sign designating the street in front of the new Engineering Center, Engineers Plaza. Watching from left to right: H. C. Bernhard, a member of the firm of architects responsible for designing the building; Andrew Fletcher, former president of the United Engineering Trustees; and Willis F. Thompson.

C. M. Brinckerhoff, left, receives award from R. D. Lilley, president of the Columbia Engineering School Alumni Assn.

Brinckerhoff Receives Award

Charles M. Brinckerhoff, president of The Anaconda Co., was named the 1961 recipient of the Egleston Medal, Columbia University's highest award for "distinguished engineering achievement." Presentation of the Medal was made at ceremonies held in the Rotunda of Low Memorial Library on Saturday, October 21. The presentation ceremony was part of the annual Engineering Dean's Day program.

The citation which accompanied the Award reads as follows: "The Columbia Engineering School Alumni Assn. has the honor of awarding the Egleston Medal for distinguished engineering achievement to Charles M. Brinckerhoff, metallurgical engineer; mining engineer; executive director of companies in the field of world metal resources, particularly as president of The Anaconda Co.; devoted to the betterment of inter-American relations in the finest traditions of the engineer-diplomat; industrial representative for 23 years in Latin America enhancing both personal and corporate integrity in those countries where he served; holder of international honors in his field; devoted alumnus of Columbia and member of the Columbia Engineering Council; steeped in the best tradition of his profession and ambassador, without portfolio, for that profession and the U.S., both here and abroad, to the advancement of human welfare and human relations."

1962 Dues Bills

Notice is hereby given that dues for the year 1962 are payable Jan. 1, 1962, as follows: Members and Associate Members, $20; Junior Members for the first six years of Junior Membership, $12, and thereafter, $17; Student Members(including an annual subscription to a monthly journal), $4.50. Dues bills were mailed the first week of November. Prompt payment will assure uninterrupted receipt of the publications desired in 1962. If, for any reason, a bill is not received within a reasonable time, please notify AIME.

WAAIMES Plan Annual Meeting

MRS. LYMAN H. HART

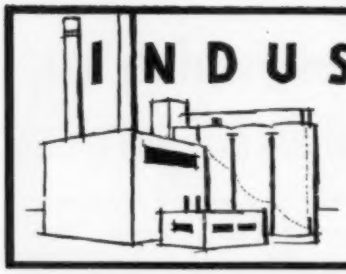
The Woman's Auxiliary of AIME, under the able leadership of Mrs. H. Eakland, Jr., Chairman, and Mrs. Andrew E. Beer, Vice Chairman, have planned a round of varying events to interest all of the women attending the 91st Annual Meeting of AIME to be held in New York February 18 to 22.

Registration begins Sunday, February 18 from 1:00 to 5:00 pm in the Penn Top Corridor of the Statler-Hilton Hotel and continues Monday from 8:00 am to 5:00 pm in the Mezzanine Exhibit Hall.

On Monday morning the members of New York Section of WAAIME will be hostesses at a Coffee Hour in the Washington Room of the Statler-Hilton from 8:00 to 11:30 am. Gentlemen are invited.

This year's program features a tour of the AIME offices in the new United Engineering Center. The tour is scheduled for 3:30 Monday afternoon. A Round Table Meeting is to be held Tuesday morning with Mrs. Norman Sather as chairman, and the WAAIME Annual Meeting will be held Wednesday morning with Mrs. Lyman H. Hart, 1961-62 President, presiding. Both events will be held in the Baroque Suite of the Plaza Hotel.

On the frivolous side—two fashion shows have been arranged—a luncheon fashion show in the Grand Ballroom of the Plaza Hotel on Tuesday and a buffet luncheon in the foyer of the Baroque Suite of the Plaza on Wednesday featuring a showing of furs and hats. Door prizes will be given on both occasions.



INDUSTRIAL MINERALS NEWSLETTER

Post-Meeting Thoughts on the CIM-SME Ottawa Gathering

The Ottawa joint meeting of our Division with our counterpart in the Canadian Institute of Mining and Metallurgy was covered by a picture story in the November issue of MINING ENGINEERING. So, enough said, except that all attendees are agreed that it was a fine, enjoyable, instructive and intellectually profitable meeting and that the social functions were outstanding.

Nik Cavell, former Canadian High Commissioner to Ceylon, drew newspaper headlines for his banquet talk on the need of the free world for a positive program. More than anything else, he said the free world needs a strong, forceful constructive joint program which states what the democracies stand for, rather than what they are against.

A novel system for arranging post-meeting field trips was followed. A map and complete brochure of all operations open to field trips were made available to each attending member. Each then arranged, with assistance of the committee, to visit the installations of especial interest to him. Many varieties of trips were thus available. Host companies were most gracious and helpful.

An example of the tours is demonstrated by some of the attractions in the "Asbestos County." Tour headquarters were set up by the Thetford Mines branch of CIM at the Thetford Mines Golf and Curling Club near Thetford City, Que. At Asbestos, Que., Johns Mansville Co. set up tour headquarters at the Iroquois Club. At both headquarters trips, luncheons and dinners were scheduled. The trips included underground, open pit and plant operations.

Gleanings from the Press

The industrial minerals industry continues to make headlines throughout the country. Some representative items are presented that demonstrate the growth of the industrial mineral industries, as well as some of the problems facing it.

Sale of a uranium empire built by a once poor prospector, Charles A. Steen, has been reported. Freeport Sulphur Co. is said to be negotiating the purchase at a price of $26 million, of which Steen and associates would receive $14 million as their share. Hidden Splendor Mining Co. and American Zinc, Lead & Smelting Co., part owners, would receive $5 million and $1.7 million respectively. The public owns 200,000 shares of URECO stock valued at $10 a share. After Steen discovered uranium in Big Indian Wash in San Juan County, Utah, he estimated the deposit worth a million dollars. His Mi Vida mine is now reported to have reserves worth approximately $200 million (gross). (Denver Post) [Who says there is no chance for the prospector today?—*L. W. D.*]

U.S. Beryllium Corp., Colorado, reports increased production. It is now supplying one ton a day of 8+% BeO ore to Mineral Concentrates & Chemical Co. of Denver. The ore is mined from the Boomer and Redskin mines on Badger Flats, west of Pikes Peak. *(Colorado Springs Gazette)*

The *Arizona Republic* reports that the asbestos industry of Arizona is growing. Much of the production from the state is purchased by the Federal Government to be woven into fabric and used to cover electrical wiring on Navy ships. Other grades are used in the filtration industry.

San Jacinto Petroleum Corp. has arranged with Utah Potash Co. to drill an area of 30,000 acres on the Salt Valley anticline, Grand County, Utah. It is about six miles north of Seven Mile anticline, controlled by Texas Gulf Sulphur, which is constructing a $30 million potash mine and mill. *(Salt Lake Tribune)*

The new $15 million trona facility at Green River, Wyo., will be completed and ready for production in mid-1962, according to Stauffer Chemical Co. Production will be from recently developed deposits that are 800 to 900 ft beneath the surface. It is a joint venture of Union Pacific RR and Stauffer Chemical Co. *(Salt Lake Tribune)*

Zoning Problems

The San Jose City Council denied a permit for Santa Clara Sand & Gravel Co. to operate a quarry on Piedmont Road, Santa Clara County, Calif. Local citizens had protested that the operation would produce a dust nuisance to homes and orchards, as well as a traffic hazard to school buses and children. *(San Jose News)*

Santa Clara County, Calif., planners and quarry operators have agreed on a standardized set of controls for new quarry sites. The controls do not affect existing quarries unless the owners seek to enlarge them. A key section in the document is aimed at insuring that the land be left in reasonably good condition when the quarrying operation is completed. Other provisions are designed to protect stream beds and control dust, noise, traffic and appearance. *(San Jose Mercury)*

Petitioners fighting intrusion of gravel pits into Tujunga Wash, Los Angeles County, Calif., suffered a setback. The California Court of Appeals reversed the decision of the superior court which had ruled that the city's denial of a license for a gravel pit was legal. The petitioners plan to appeal to the California Supreme Court. *(Tujunga Record Ledger)*—*Leon W. Dupuy.*

ROCK IN THE BOX

Mining & Exploration Division

Peele Fund

The Society of Mining Engineers seldom sponsors a fund raising program. We therefore feel that when such a program is launched, the membership should respond. Specifically, we feel that a dollar or so per member is not too much to ask in order to reactivate the Peele Award. Perhaps it is just lethargy that keeps members from addressing an envelope and writing a check, for surely most of us can afford a buck.

If you have lost the address, here it is again:

Fund for Peele Committee
c/o Society of Mining Engineers of AIME
345 East 47th Street
New York 17, N. Y.

We need your dollars for this award. Little enough is being done to acknowledge the work of younger mining engineers. The Peele Award is one way to give this needed recognition.

As we go to press there is $293 in the Fund. This represents an increase of not quite $100 since we reported to you in September. At that time there was an even $200 in the Fund.

Annual Meeting

Getting on to other subjects, it is time to talk again of the Annual Meeting. A few months ago we gave a brief rundown of the program as it was shaping up. Final (or semi-final) plans indicate that a fine series of papers will be presented without too much deviation from our preliminary outline.

One phase of the meeting was not discussed, however, in this column: that phase which concerns the running of your organization. Over the past 15 years or so many changes have taken place in the AIME. Many of us have noted only the increase in dues (which, incidentally, has not matched the overall price index increase for the same period). These changes in a real sense have their start at annual meetings. It is at these meetings that the members and committeemen have a chance to meet and talk. You who are attending the meeting should come, not only with the idea that the papers will be interesting and the social hours pleasant, but also with the thought of contributing something to the operation and success of the AIME as a functioning organization. As we have said so many times on this page—your thoughts and suggestions are needed, for without them, the society would cease to serve a useful purpose.

M & E Division Organization

A member of our division who has been working hard along these lines is Brower Dellinger, Secretary of M & E Division. He has been hard at work on a study of officers and their duties and the various committees of the Division and their duties, methods of selection and the time element necessary to keep a smooth running organization. Lines of succession fit into the study as well as many other phases of the operation of the M & E Division. Brower Dellinger feels, and we heartily second him, that the membership should submit any suggestions concerning these subjects. Therefore, if you have any thoughts on officers, their duties and/or selection; committees, their duties and/or their selection; terms of office or the like, send them off to:

Brower Dellinger
National Lead Company
Tahawus, N. Y.

Or, bring your thoughts with you to the meeting, not with the intention of sulking and muttering in the corner that things aren't the way they used to be, but rather with the intention of talking, contributing and adding to both formal and informal meetings.

Reflections on the AMC Technical Sessions

As usual, the Mining Congress 1961 Metal Mining and Industrial Mineral Conference in Seattle was a great success. Much favorable comment was heard about the convention this year.

The sessions on land management were very well attended. The topics under discussion were all controversial and all evoked considerable discussion. The recent wilderness legislation and the interpretations of law pertaining to valid discovery and nonmetallic mineral claims were all considered.

Much more of the program of all sessions was devoted to management problems and the techniques of modern management. Computers were a part of at least five papers. A whole session was devoted to management tools and techniques. Although perhaps it cannot yet be called a shift, at least a trend away from the detailed papers on "how to do it" was indicated.

This trend brings us to the question of the month: "To what level should a mining convention be geared?" Should the majority of papers concern themselves with how to do a detailed job, or should they point out the broader aspects of management and engineering? We seem to circle back to the educators' problem of trade school vs. theory and background.

The Mining Congress has, by its very nature, always tackled political issues. They also seem to be leaning towards the fields of management, theory and operations research, and away from the very detailed papers. This seems to be a step in the right direction. Are there any comments?

Blasting Research

Research for the mining industry is often neglected, or pursued in only a cursory fashion. The other day we received a brochure announcing the Blasting Research Assistance Program of the Mining Department at Pennsylvania State University. In B. J. Kochanowsky's words, "the primary goal of this program is to find ways for reducing production cost in industry. Therefore, your helping us to educate future engineers needed in industry and to improve our research facilities will enable us to help you."

Dr. Kochanowsky has already contributed much to the world's knowledge of blasting, and we commend his initiative in starting off the Blasting Research Program.

M&E DIVISION NEWS EDITOR

Peter B. Nalle

Riverside Cement Co.
Box 832
Riverside, California

Around the Sections

• The **Washington, D. C.** Section heard John M. Kelly, Assistant Secretary of the Interior for Mineral Resources, discuss topics of current interest in the U.S. mineral economy at its November 7 meeting. As usual, the members met for the dinner meeting in the dining room of the Broadmoor Apartment Hotel.

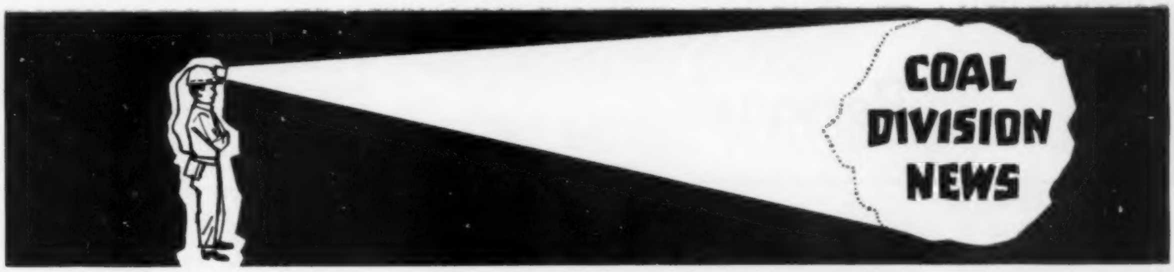
• More than 50 people turned out for the first meeting of the 1961-62 season of the **Chicago Section** on October 4. The attraction was the guest speaker James J. Reynolds, Assistant Secretary of Labor, whose topic, *The Labor Department Looks at the 60's*, had a direct appeal to the mining, minerals and metallurgical interests in the Section. A number of industrial managers from a wide variety of industries in the Chicago area attended. Mr. Reynold's gave a pertinent forecast of the labor picture for the decade to come. As a departure, this meeting was held at the Armour Research Foundation of the Ilinois Institute of Technology rather than the Chicago Bar Assn.

The Section's November 1 meeting was Student's Night. The audience, back at the Chicago Bar Assn., heard G. E. Darcy, Jr., manager of the Research Program Div., Ordnance Materials Research Office, Watertown Arsenal, talk about materials for solid propellant rocket motors.

• The Annual Ladies' Night Party was held by the **Tucson Subsection** (Arizona Section) at the Sahuaro Vista Guest Ranch in the Tucson Mountains, northwest of the city on September 16. More than 100 people attended. Numerous sports facilities at the Ranch were available to members and guests during the afternoon. Highlight of the party was a beef barbecue prepared by the Subsection Treasurer, Bob Lansing. A group of University of Arizona College of Mines students and their wives attended, following a day spent in enrolling for the fall semester at the University.

The October 11 meeting of the Subsection, held at the Cliff Manor Motor Hotel, featured the visit of AIME President R. R. McNaughton. Other guests present for the occasion were E. O. Kirkendall, General Secretary of AIME and C. J. Hicks, Western Field Secretary. Again attendance topped the 100 mark, including 24 members of the Student Chapter at the University of Arizona. Mr. Hicks spoke of Arizona mining industries' cooperation in hiring students for summer employment. Mr. Kirkendall described the United Engineering Center and complimented the Arizona Section's contribution towards the construction of the building. He also gave a brief resume of the organization within AIME. President McLaughlin began his talk with a description of the responsibilities of members of AIME to their profession beyond their daily jobs. Representation of each Section and Subsection through the Council of Section Delegates was also explained. He concluded his talk with a description of COMINCO, illustrated by color slides.

• The **Philadelphia Section** held its first meeting of the fall in The Presidential Apartments, Madison House on October 19. Cocktails and dinner preceded the meeting which was presided over by James M. B. Kaiser in the absence of the Chairman, Brodie E. Crawford. The evening's speaker was Robert M. Grogan, manager of the Geology Div., E. I. du Pont de Nemours & Co., who discussed titanium mineral deposits in Australia. Slides were used for illustration.



Illinois Mining Institute Annual Meeting

The 69th Annual Meeting of the Illinois Mining Institute held October 20, at Springfield, Ill., was of interest to Coal Division members on a number of scores. The technical session held in the morning was presided over by W. A. Weimer of Peabody Coal Co. and former Newsletter Editor; all of the day's speakers were AIME members. The luncheon speaker was George A. Lamb, and J. P. Weir was installed as vice president. In addition, of course, the subject matter of both the technical session and the luncheon address was of vital concern to coal men, as the presence of more than 400 people attested.

The technical session opened with a paper by Robert D. Greer, The Jeffrey Mfg. Co., Columbus, Ohio, entitled *An Equipment Manufacturer Looks at Future Customer Coal Petrography Applied to Coking Problems* by John A. Harrison, Illinois State Geological Survey, Urbana, followed, and the session closed with Louis C. McCabe's paper *Trends in Air Pollution Activity*. He is president of Resources Research Inc., Washington, D. C. Ample opportunity was allowed for discussion of each paper.

Supplanting the traditional evening banquet, an all-institute luncheon meeting was held in the banquet hall of the Hotel Abraham Lincoln. Following the business meeting, George A. Lamb, Director of Coal Research, talked about coal's potential. The meeting ended with the presentation of the gavel to newly elected president Robert J. Hepburn.

Office of Coal Research Awards Second Contract

The Office of Coal Research recently awarded a $142,900 contract to Bituminous Coal Research Inc. to study the preparation, transportation and utilization of super-fine pulverized coal. Its purpose is to discover an economical method whereby pulverized coal can leave the mine and be used in plants and factories in self-contained continuous systems, eliminating storage and disposal operations.

Specific contract objectives are to develop systems for preparing pulverized coal with the removal of sulfur and ash, continuous transportation from mine to factory, and designing and operating boilers to burn superfine coal efficiently in continuous sequence with transportation systems. The contract also calls for study of superfine coal as a raw material in gasification, carbonization and similar methods. The study is expected to take approximately two years.

Coal Mining Institute of America Annual Meeting

For members in the area, we call your attention to the 75th Annual Meeting of the Coal Mining Institute of America to be held December 14 and 15 at the Penn-Sheraton Hotel in Pittsburgh. An interesting program has been arranged which features Stewart L. Udall, Secretary of the Interior, as guest speaker at the annual dinner on Thursday evening, December 14.

Following the business meeting on Thursday morning, two papers will be presented: *The Challenge to Management* and *Revisions of the Bituminous Mining Laws of Pennsylvania*. Four papers will be presented at the afternoon session dealing with mine safety.

Friday morning's session is to be devoted to roof control. The four papers include: *Roof Control*, Charles T. Holland; *Control of Roof with Hydraulic Jacks*, E. P. Sheriff; *Methods of Controlling Roof at Intersections and Junctions Underground*, R. W. Stahl; and *Resume of Roof Support Methods Used in Coal Mines*, A. J. Barry. The afternoon sessions will start off with a paper by W. A. McCurdy on the selection of production equipment. This will be followed by a symposium on high productivity in underground mines.

Personals

Correction

The item on **John Y. Cole, Jr.,** on page 1176 of the October issue of MINING ENGINEERING erroneously reports that he is mine foreman for Cia. Minera Asarco, S.A. Mr. Cole is in fact employed by Kaiser Gypsum Co. Inc., Oakland, Calif., as executive assistant to the vice president of operations.

In inaugurating a new geophysical research program, the California State Division of Mines and Geology has added **Rodger H. Chapman** to its staff to head the program. Chapman's last position was with the Columbia-Geneva Div., U.S. Steel Corp. where he was senior exploration geologist specializing in geophysics.

Magma Copper Co. recently announced the following changes in management personnel. Replacing **Darrell Gardner,** who retired as general manager of Magma's operations at Superior, Ariz., after 36 years with the company, is **Garvin L. Augustadt,** formerly general superintendent and now general manager of the Magma Arizona RR. **Hubert J. Steele,** formerly assistant mine superintendent, assumed the position of general superintendent of operations and **Walter W. Chafey,** formerly division foreman, assumed the position of general mine foreman.

At the end of a short home leave, **Gene T. Hilton** returned to Korea early in December for another two-year tour with the U.S. International Cooperation Administration mission there. He has been assisting in the coal mining program being carried on by the government-owned Dae Han Coal Corp., privately operated mining firms and the Korean Coal Operators Assn. in introducing better techniques and up-to-date equipment.


R. H. FEIERABEND


A. L. THURMAN

Raymond H. Feierabend was recently elected a vice president of Freeport Sulphur Co. and will be responsible for the company's sulfur operations in Louisiana. Mr. Feierabend joined Freeport in 1942 and from 1953 to 1956 served as superintendent of the company's largest mine at Grand Ecaille, La. In 1957 he was named assistant vice president and placed in charge of the development of Grand Isle, the world's first offshore sulfur project.

Astor L. Thurman has recently been appointed general manager of McNally-Bird Engineering Co. Ltd., Calcutta, India, a new company formed by The McNally Pittsburg Mfg. Corp. and Bird & Co. Ltd. McNally-Bird's manufacturing facility will be located at Kumardhubi and will produce equipment for the basic industries in India, including coal, ore, cement, ceramics, aggregates, etc. It is expected to be in operation before the end of summer, 1962.

Mr. Thurman has over 24 years of experience in heavy machinery. Most recently he was president of Lombard Mfg. and vice president of Lombard Corp., mill machinery builder of Youngstown, Ohio.

Robert C. Hills has been elected president of Freeport Sulphur Co., succeeding **Charles A. Wight** who became vice chairman of the board. Mr. Hills has been a director and executive vice president of the company since 1955. During that time he has been in charge of Freeport's present five sulfur-producing properties and was responsible for the construction and start-up of the world's first off-shore sulfur mine at Grand Isle, La.

Henry W. Erickson has moved to Ormond Beach, Fla., following his retirement from Allis-Chalmers Mfg. Co. at the end of October.

C. J. Potter, president of Rochester & Pittsburgh Coal Co., has been named as the coal industry's representative to the staff of the Senate Interior Committee for its investigation of a national fuels policy.

Merle H. Guise has returned to Palm Springs, Calif., after an extensive scouting trip through the Northwest and Canada and attendance at the Alaska Sourdough Pow-Wow in Seattle.

Following his discharge from the U.S. Army, **Richard E. Guthrie** has gone to work in the New York office of American Metal Climax where he is receiving extensive training.

Leslie S. Wilcoxson, vice president of the boiler division of Babcock & Wilcox Co., was recently elected chairman of the Welding Research Council-Engineering Foundation for a three-year term.

L. S. WILCOXSON

R. S. NEWLIN

Richard S. Newlin, vice president in charge of operations, was elected a director of The Anaconda Co. at a recent board of directors' meeting. He replaces **Robert E. Dwyer** who resigned after 28 years as a director of the firm. His association with the company began 58 years ago in Anaconda, Mont. Mr. Newlin has been associated with the Anaconda organization since his graduation from Princeton University in 1922, serving in various executive positions in Western mining operations and in Chile.

Carl W. Hoffmann is on leave of absence from Mount Isa Mines Ltd., Queensland, Australia, to attend the Stanford University Graduate School of Business.

Following graduation from Washington University, **Vernon C. Ude** spent the summer working for Pan American Oil Co. in its geophysical department. He is now a teaching assistant at Cornell University.

Georges Ordonez, formerly chief geologist, Kennecott Copper Corp., has started a consulting practice in Mexico City. He will concern himself with the exploration, evaluation and development of mining properties.

Obituaries

Joseph Gold (Member 1956) succumbed to a heart attack June 10, 1961. He was born Oct. 3, 1922 in Brooklyn, N.Y. and continued to live there throughout his life. At the time of his death Mr. Gold was manager of the Diamond Mining & Drilling Bit Dept. of Diamond Tool Research Co. He had been affiliated with the firm for seven years. Prior to that he had been with the industrial diamond firms of J.K. Smit & Sons Inc. and Aton Smit & Co. Inc.

Duncan Forbes (Member 1944) died June 19, 1961, in Sussex, England at the age of 70. He and his wife had returned to England in 1958 to spend his retirement. Mr. Forbes was born in London and was a graduate of the University of London. He first came to the U.S. in 1914 as a draftsman and assistant estimator for Arizona Copper Co. Except for a brief period with the British Army in World War I, he remained in the U.S. working for a number of firms until his retirement. In 1942 he moved to Knoxville, Tenn., where he was associated with Foote Mineral Co. and Electromanganese Corp.

Hugh E. McKinstry (Member 1921) died June 30, 1961 at the age of 65. He was born in West Chester, Pa., graduated from Haverford College and received his M.S. degree from the Massachusetts Institute of Technology. Upon completion of his studies, he went to Peru as a geologist with Cerro de Pasco Copper Corp. In 1924 he accepted a position on the faculty of Harvard University, where he remained until his death.

Membership

Proposed for Membership

Society of Mining Engineers of AIME

Total AIME membership on Oct. 31, 1961, was 35,609, in addition 2,225 Student Members were enrolled.

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The Institute desires to extend its privileges to every person to whom it can be of service, but does not desire as members persons who are unqualified. Institute members are urged to review this list as soon as possible and immediately to inform the Secretary's office if names of people are found who are known to be unqualified for AIME membership.

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Necrology

Date Elected	Name	Date of Death
1941	J. Edward Berg	Aug. 9, 1961
1928	Maxwell S. Burt	Aug. 1954
1936	T. P. Colclough	Sept. 22, 1961
1955	Arthur Decoux	Aug. 24, 1961
1938	N. DeVoogd	Oct. 14, 1961
1912	A. L. Flagg	Apr. 27, 1961
1955	Fred M. Griswold	Unknown
1954	Ralph C. Karlsten	June 27, 1961
1935	R. F. Mahoney	Oct. 3, 1961
1956	D. W. McKee	Dec. 24, 1959
1940	A. D. Moir	May 19, 1961
1948	L. C. Mosley	Aug. 28, 1961
1948	W. Rothenhoefer	May 1961

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Continued On Page 1370

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For additional items, see page 1369 and 1371

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